SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME LII APRIL, 1931 NUMBER 4

PRIMARY MALIGNANT TUMORS OF THE URETER

M. J. RENNER, M.D., NEW YORK

From the Institute of Pathological Anatomy of the University of Vienna, Professor Dr. R. Maresch, Director

MALIGNANT growths which secondarily involve the ureters are conditions with which the pathological anatomist is quite familiar. They are especially common in cases of advanced carcinoma of the uterus. Occasionally also in the presence of a primary carcinoma of the abdominal viscera, the ureter is compressed from outside by carcinosis of the peritoneum or by metastatic involvement of the abdominal lymphatic glands, or perhaps the ureter may even become infiltrated. However, it is a well known fact that for a considerable time the wall of the ureter will resist involvement by the tumor (Wertheim). Metastatic nodules in the ureter occur very rarely but when present usually arise from the lymph stream. As a rule in the cases of secondary malignant growth the clinical diagnosis offers no difficulty when the lumen of the ureter has become constricted, but if the growth is primary in the ureter the diagnosis proves much more difficult. Up to the present time diagnosis has been accurate only in the minority of the cases examined. Thus it is easily appreciated that, from a clinical point of view, primary growths of the ureter are of great importance since a cure may be obtained by timely surgical treatment (ureterectomy, nephrectomy).

Among the *primary growths* of the ureter, the non-malignant, villous growths similar to those of the renal pelvis and bladder, are most frequently observed and very often occur simultaneously. Cases of generalized papillomatosis of the urinary passages should, according to Stoerk, on no account be considered as neoplastic, but rather as chronic inflammatory hyperplasias. At any rate, reference to these non-malignant villous growths of the urinary passages seems to be justified, because malignant epithelial growths undoubtedly can develop from them. Apart from this, it will be necessary to revert to this question in discussing some of the epithelial neoplasms of the ureter mentioned in the literature.

Among the *primary malignant growths*, carcinoma is the most common. Rayer (1842) was the first to observe primary carcinoma of the ureter and Chiari (1916) found 17 cases described in the literature. Since then the number of cases has been tripled, so that it may now be assumed that about 50 cases of primary carcinoma of the ureter have been reviewed. Among the cases described, the majority were papillary, while the remainder were of solid growth.

With reference to the mesenchyme growths of the ureter, primary tumors of the connective tissue occur, such as myomata and fibromyomata (Kaufmann, Weinstock, etc.), but these are much rarer than carcinomata.

Mixed tumors are never found in the ureter but they have occurred in the renal pelvis, while carcinosarcomata have been found in the bladder.

We propose to describe a recent case of primary malignant tumor of the ureter for the following reasons: first, this case seems to be of exceptional interest, especially since exact cystoscopic and radiological data are available; second, there is the exceptional anatomical condition which, as we shall see later, led to an erroneous clinical diagnosis of the primary growth in the bladder; and third, because the microscopic structure of primary malignant neoplasms of the ureter has, heretofore, never been observed.

In this case the patient was a man, 71 years of age. Postmortem examination was made in the Institute of Pathological Anatomy of the University of Vienna on June 15, 1929.

Gustavus S.,[1] 71 years old, entered the clinic on May 12, 1929. He had had gonorrhœa at the age of 30, dysentery and articular rheumatism in 1917. He had had no urinary trouble of any kind, until suddenly, on May 4, 1929, blood appeared in the urine. The bleeding became more and more severe, with strangury and pains during micturition. Treatment consisted in the washing of the bladder with sodium bicarbonate. As there was no improvement, the patient was admitted to hospital.

Examination at this time showed that there was no point which was painful to pressure in the region of the kidneys, but on the right side there was a point of resistance on palpation. The urine was cloudy and mixed with blood, albumin was definitely present, and sugar absent. In the sediment were plenty of erythrocytes, leucocytes, and epithelial cells.

The bladder could be washed out quickly. It had a small capacity. Cystoscopically no diagnosis could be made because a red disc always appeared.

X-ray examination was made by Dr. Haslinger. A flat plate of the urinary bladder showed nothing exceptional. When the bladder was filled with air or contrast solution, an indistinct rim about 1½ inches in width was seen. This rim could not be caused either by the contained air or by the sodium bromide alone. In the center of the bladder cavity there was a symmetrical dense shadow (Figs. 1 A and B).

Suprapubic cystotomy was performed on May 24, 1929, and a tumor about the size of an apple, nodular but comparatively soft and having a thin pedicle, was excised from the region of the trigonum. After the operation, the condition was at first satisfactory, then anuria and a condition of semiconsciousness supervened. On June 14, 1929, the patient died with signs of uræmia.

[1] K. Haslinger reported on the clinical and A. Feller on the anatomical diagnosis of the case, at the meeting on July 3, 1929, of the Wiener urologische Gesellschaft. The history of this case, together with the X-ray pictures, was very kindly placed at our disposal by the director of the 2d surgical clinic of the university, Professor Dr. Hochenegg, to whom thanks are herewith expressed.

Clinical diagnosis. The diagnosis after high section and extirpation of the sarcoma of the urinary bladder was: neoplasm of the right kidney, cirrhosis of the kidney, uræmia, and bronchopneumonia.

Macroscopic examination of the extirpated tumor of the bladder (Fig. 2) showed a spherical tumor measuring 7 by 4 by 3.5 centimeters in its longest diameters. In the place where the excision was carried out, a stem about 1 centimeter in length and 2 to 3 centimeters in diameter was disclosed. The stem emanated from a hilum-like contraction on the surface of the tumor. Otherwise, the surface of the growth was fairly smooth and was mostly of a dark red color. In places, the continuity of surface had been disturbed by the shedding of superficial parts of the tumor, and these, due to necrosis, possessed an indistinct muddy color. On section, the growth consisted partly of a whitish gray homogeneous mass of fibrous tissue and to a larger extent of a dark red tissue, equally structureless but somewhat more soft and spongy.

Microscopic examination revealed, in several pieces taken from the various parts of the growth, whitish, well preserved particles, which consisted throughout of a fibrous stroma very rich in vessels. In some parts, there was an anomalous arrangement, in others a fascicular structure (Fig. 3). In this stroma of varying density, large spindle cell elements were found. These showed distinct polymorphism and polychromatophilia in addition to numerous mitotic figures. In the superficial parts of the growth, which showed this structure throughout, an infiltration of polymorphonuclear leucocytes with various necrotic areas was found. Toward the depths of the tumor, one could see how the spindle cell elements of the tumor were fascicularly arranged and were, in many places, already forced apart. Thus the fibrous structure of their interstitial substance became more and more indistinct, showed gaps, and in many cases stained light blue with hematoxylin. The blue coloring became slowly more distinct as the structure of the interstitial substance became more granular; at the same time the spindle formed cell elements slowly disappeared, giving place to starry forms, so that in the large parts the character of myxomatous tissue was obtained (Fig. 4). As a third type of tissue, small irregularly shaped areas were found. These were surrounded by nearly structureless spindle cell tissue. They stained pink with eosin and contained roundish cells in fairly irregular order. These were sharply defined and looked like cartilage cells (Fig. 5). Moreover, the considerable amount of polymorphism and polychromatophilia was noted in the cells and in places there was a deposit of calcium in the cartilage areas.

In the section examined, there was also found a fairly extended but localized hyalinization.

Sections from the macroscopic parts of the red portion of the tumor show an exactly similar structure, with an extraordinary richness of vessels; they were, however, almost necrotic. The vessels of these regions were often filled with layers of thrombi.

Fig. 1A. Roentgenogram of the urinary bladder filled with air.

Fig. 1B. Roentgenogram of the urinary bladder filled with sodium bromide.

The elementary substance, however, reverted to a myxomatous condition. In several places in the necrotic parts of the tumor, irregular calcified areas could be found, which partly reminded one of spicules of bone.

With the staining of collagen fibrils, according to Bielschofski-Maresch and Mallory, a very dense and fine plexus of fibers were found in the spindle cell parts of the tumor. This enclosed the several cell elements while the meshes of the network became larger and looser in the myxomatous regions. The cartilage areas were surrounded by a dense fibrous structure like a perichondrium. In the elementary substance of the cartilage itself, however, only a very delicate network could be found.

These findings would indicate the presence of a spindle cell sarcoma of large cells, rich in vessels, with an extensive change toward a myxomatous condition, with areas of necrosis and cartilage formation.

At the postmortem examination (Assistant Dr. Feller), the following was ascertained:

Genito-urinary tract: The anterior wall of the urinary bladder, near the top, was fixed to the abdominal wall and there, above the symphysis, a urinary fistula—large enough to allow the passage of the little finger—was present (Fig. 6). The urinary bladder itself was comparatively small, thick walled, and hypertrophic. The muscularis mucosæ was also thickened and intensively injected. Near the orifice of the right ureter, a pedicle of tumor tissue, a few millimeters in length, was protruding. It was somewhat irregular in shape and about the thickness of a thin lead pencil. On opening the right ureter, which throughout its length was large enough to admit one or two fingers (increasing in size as it approached the renal pelvis) its lumen was found to be filled with tumor tissue. This was sausage shaped, cylindrical in form, grayish white in color, and in places was permeated with blood. Approximately at the junction of the upper and middle thirds of the ureter, the substance of the tumor was adherent to the posterior wall over a certain area; otherwise it showed a smooth, free surface. Toward the top of the sausage shaped tissue, the tumor ended in the shape of a hook, bent outward and posteriorly, about 3 centimeters below the renal pelvis. In the downward direction, the tumor became smaller, conically toward the orifice of the ureter and showed in place of the latter, a circular constricted groove, to which the previously mentioned pedicle was attached and from which it reached into the urinary bladder.

Above the upper end of the tumor substance, the right ureter was bigger in diameter than the size of two fingers and ended in a membranous pouch, larger than a child's head. This corresponded to the right renal pelvis, which upon being opened was found to contain about half a litre of thin, brownish

Fig. 2. Tumor of the urinary bladder removed at operation. It corresponds to the vesical end of the growth of the right ureter. Natural size.

fluid. The calyces were changed into large cystic cavities, showing wide communications with the sac shaped renal pelvis. One of the calyces at the upper pole of the right kidney was especially big and cyst-like and was lined with a brownish material. The parenchyma of the kidneys had been thinned down to a few millimeters by the protrusion of the cyst-like calyces.

The left kidney was slightly enlarged and on its surface a large number of abscesses could be seen, arranged in groups and about the size of millet seeds. Corresponding to these, a large number of yellow streaks were noticed in the region of the renal pyramids. The pelvis of the left kidney was moderately enlarged, reddened, and filled with pus. The left ureter was also somewhat wider than usual, its muscularis mucosæ being reddened and containing some pus in its lumen.

Other organs: Apart from the signs of uræmia, a luetic mesaortitis and extended bronchopneumonia of both inferior lobes, were found.

Microscopic diagnosis. For the histological examination a slice of the ureteral tumor was taken, together with the ureteral wall at the site of the growth. The numerous sections which were made, were stained with hematoxylin-eosin, according to van Gieson, Mallory, Bielschofski-Maresch and according to Gram-Weigert, with thionine for fibrin. Figure 7 is an enlarged photomicrograph of a section from the slice mentioned. The wall of the ureter was cut longitudinally anteriorly during the post-mortem examination, was unfolded and stretched to a slight degree; its still normal anterior parts could no longer be seen in the picture. Adjoining the parts of normal muscularis mucosæ we found, in the left half of the picture, in place of the muscularis mucosæ, a papillary tumor with disintegrating surface. Figure 8 is a still greater enlargement. In this picture, in a very fine stroma rich in vessels, epithelium of the transitional type is seen. The cells are arranged in many rows and show distinct polymorphism and polychromatophilia. Next to these flat villous parts of the growth, which throughout, occupied only the region of the ureteral muscularis mucosæ and did not penetrate into the muscularis, we found a large part of the growth, which in the figure showed a roundish form (Fig. 7). The central parts were extensively hyalinized and consequently stained red with van Gieson's stain, while the preserved parts, situated nearer to the surface showed in places the structure of a fairly polymorphous spindle cell sarcoma with a moderate number of giant cells and in other places, while retaining their sarcomatous character, appeared to be distinctly myxomatous. Reproduction of the pictures of these parts of the growth appeared unnecessary as, in every respect, they were similar to those which had been already described in connection with the extirpated bladder tumor. In the hyaline central portion, small islands of hyaline cartilage, similar to that in the tumor of the bladder, were found. While most of the sarcomatous parts of the growth were situated above the muscularis without penetrating it, we could distinctly observe in the right half of Figure 7, how a wedgeshaped peg-like process of the growth which was principally myxosarcomatous, penetrated between the layers of the muscularis, splitting it like a fork. The border line between the epithelium and sarcomatous part of the growth was of particular interest, because cancer alveoli could be noticed in the middle of a sarcomatous stroma (Fig. 9). In connection with *special stains*, it should be mentioned that with silver impregnation according to Bielschofski-Maresch, a very fine network of fibrous tissue, surrounding the individual cells of the tumor, can be demonstrated in sarcomatous spindle cell and myxomatous parts, while in the epithelial parts of the growth, fibers capable of impregnation, are found only in the delicate stroma.

With Mallory's stain, the same conditions may be observed in the collagen fibers.

With thionine, the elementary substance in several regions of the myxosarcomatous parts of the growth may be stained a dark red. The elementary substance of the cartilage stains a light pink.

According to Gram-Weigert, several myxomatous portions of the growth and the cartilage islands stain bluish, similar to the staining with thionine; here and there, delicate reticula of fibrin may be seen, quite superficially in the parts of the growth which have undergone a degenerative change.

The histological examination of the hydronephrotic and hæmatonephrotic *right kidney* showed that the parenchyma of the kidney had changed into a sac, only 2 to 3 millimeters thick. This sac consisted partly of hyaline, callus tissue in which renal elements could no longer be recognized, while in places the glomeruli which had completely changed into connective and hyaline tissue, could still be recognized as a remnant of the kidney parenchyma. The reddish brown substance which was mentioned in the macroscopic description as having been found in the enlarged cyst-like cavities, proved to be layers of old blood. Upon examination, several sections of these small islands of myxosarcomatous tissue in the tumor, were ascertainable.

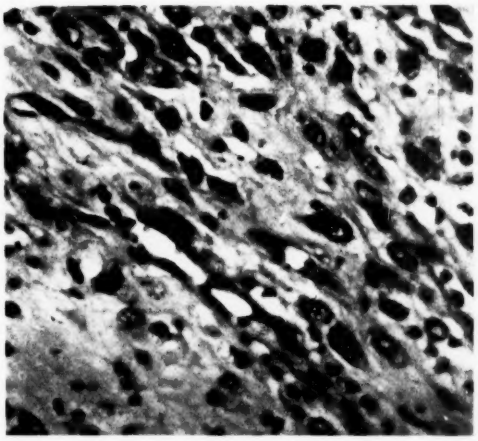

Fig. 3. Photomicrograph of section of removed bladder tumor, note spindle cell sarcomatous tissue.

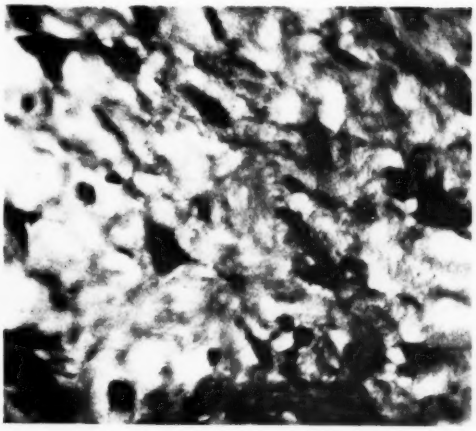

Fig. 4. Photomicrograph showing myxosarcomatous tissue.

In conclusion, we have here a man, 71 years of age, who, apparently in good health, without any previous urinary trouble, suddenly had hæmaturia 6 weeks prior to his death. As the cystoscopic diagnosis and the X-ray examination indicated a tumor of the bladder, suprapubic cystotomy was carried out 1 month before death. A pedunculated growth, resembling a fibroma and about the size of an apple, was removed from the fundus of the bladder. The spherical form of the bladder tumor, which could be seen from the X-ray picture and the macroscopic photograph and the very clear definition of the growth, which latter appeared to be attached by a thin pedicle in the trigonal area, should explain why the existence of a tumor of the ureter was not thought of at first. It is true that after the operation, a tumor of the right kidney was discovered by palpation, but it was difficult to decide on a second operation. After a period of improvement, the patient died of uræmia.

The microscopic examination of the extirpated bladder tumor resulted in the diagnosis of sarcoma, mainly spindle cell, with an extensive myxomatous change and in some places cartilage formation was present.

At the autopsy, the primary tumor of the right ureter was found, which, emanating from about the middle of the posterior wall, nearly filled the lumen completely with its sausage-like form. Extending upward, it reached almost to the renal pelvis and in a downward direction, through the ureteral orifice, reached into the urinary bladder. At the site of removal of the bladder tumor, a pedicle about 2 to 3 millimeters in diameter, was found. This protruded from the orifice of the right ureter.

The histological examination of the ureteral tumor showed that it was composed of small, flat portions which were adherent to the wall of the ureter and resembled a papillary carcinoma in type. The large sausage shaped part of the tumor which filled the lumen of the ureter was sarcomatous and corresponded in structure to that of the urinary bladder tumor in every respect. Apart from the myxomatous portions, it contained the same small islands of cartilage as did the latter. The epithelial and sarcomatous parts of the growth were not only situated next to one another, but penetrated each other so that in places cancer alveoli were found in a sarcomatous stroma. The primary tumor of the ureter must therefore be designated as a *carcinosarcoma;* the sarcomatous component of which showed much proliferation and was the largest part of the sausage shaped ureteral tumor and the tumor of the urinary bladder, which had been removed. To express the exact structure of the growth in a precise manner, one might call the primary tumor of the ureter, a fibromyxochondrocarcinoma.

In the right kidney, the typical diagnosis of hydronephrotic atrophy could be ascertained microscopically. The bleeding (hæmatonephrosis) was sufficiently explained by the microscopic diagnosis of cells of the tumor in the blood effusion of the renal calyces; and presumably had been caused by degenerative metamorphosis of tumor tissue which had settled there. The tumor elements had reached there, without doubt, because small portions of the ureteral growth had been dammed back in the urine, and in this way had been implanted in the renal pelvis.

The tumor of the ureter which had been described was therefore quite an exceptional one, both as regards its macroscopic anatomical condition and as to its microscopic structure. It could, therefore, be appreciated that a complete clinical investigation of this case offered considerable difficulties. We may consider it from every point of view as a case which stands alone in the literature.

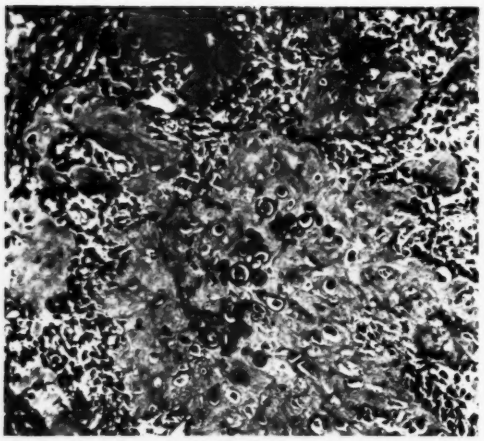

Fig. 5. Photomicrograph showing sarcomatous tissue with cartilage formation.

If we compare this case with those of primary malignant growths of the ureter which have already been published, we find, as already mentioned at the beginning of this treatise, that carcinomata are most frequently encountered. It is not necessary to give a detailed statement here, in respect to these primary carcinomata of the ureter, as such a statement, prepared with much care and given in a clear scheduled form, was published by Rousselot and Lamon in January, 1930. However, both the authors have avoided a critical discussion of their compilation and have not arrived at any conclusions in connection with their material.

It might, therefore, be advisable to emphasize a few facts.

The published cases, enumerated by Rousselot and Lamon number 49. A critical discussion of the literature in question, by Glas (1926), points out, that from this number, the case of Chevassu and Mock (1912) and the case of Toupet and Gueniot (1898) can be eliminated, as the former represents a case of non-malignant papilloma of the ureter, and the latter a tumor of the renal pelvis which had extended into the ureter. The communications of Hofmann and Finsterer (1915 and 1916), respectively numbered 24 and 26, have erroneously been counted as 2 cases, although they each refer to one and the same case. Of the compilation of Rousselot and Lamon, 46 cases remain, therefore. If to this number we add the case described by the authors themselves and the new case of Player (1928), which is not mentioned, we have a series of 48 cases of primary carcinoma of the ureter.

As regards localization, it will be found that out of these 48 cases, 32 (i.e., two-thirds) of the total have emanated from the lower half of the ureter, 5 from the middle portion, and 6 from the upper half.

In 6 cases of the first group, the growth had penetrated through the orifice of the ureter into the urinary bladder and was visible by endoscopic examination of the bladder.

As regards sex, the cases may be divided almost equally—23 males and 25 females.

A combination with urinary concretion was found in 7 cases only (12.5 per cent).

As to histological structure, papillary carcinomata were most frequent, 19 in all (i.e., 40 per cent), of all cases considered; solid carcinomata occurred 11 times (23 per cent). Besides these, a cylindrical cell carcinoma was mentioned once, an adenocarcinoma once, a transitional cell carcinoma twice, and a pavement epithelium carcinoma five times (i.e., 10.4 per cent of the cases). In the remainder of the cases, there is no histological diagnosis, or merely a designation as carcinoma without any classification.

Non-malignant papillomata, in addition to the primary carcinomata of the ureter, are found; in the case of Israel, in the surroundings of the carcinoma of the ureter; in the case of Poll, in the renal pelvis and the whole of the ureter, and in the case of Player, in the urinary bladder. These cases are certainly interesting from the point of view of showing that carcinomata can arise from non-malignant papillomata (Stoerk). The opportunity must be taken, however, to oppose the view which was apparently expressed for the first time by Israel (1910) and was adopted even more recently by Glas and Player, that primary carcinoma of the ureter or renal pelvis can cause metastases which bear "the character of a simple papilloma" (Israel) and only subsequently become carcinomatous. Glas even finds that this occurrence is "no

Fig. 6. Postmortem specimen of the whole urinary apparatus. The right kidney is hydronephrotic. The right ureter in its lower two-thirds is filled with a tumor, about the thickness of a finger.

rare" and Player, in his recapitulation, states literally: "a benign papilloma may be the metastasis of a malignant ureteral carcinoma."

It is evident that, in the cases of which the authors speak, it must have been a question, either of primary multiple papillomata (papillomatosis), in which several of the villous tumors have already become cancerous, while in others their benign character has been retained; or it is also possible that subsequently and quite independently of the carcinoma, benign papillomata have developed. The processes, assumed by Israel, Glas, and Player, could not possibly be brought into agreement with the views which we hold in regard to malignant tumors.

Sarcomatous growths of the ureter are much more rare than the carcinomatous growths. Ribbert described, in 1886, a

Fig. 7. General microscopic picture of the ureter, the cross section being cut at the point of origin of the tumor from the ureteral wall.

spindle cell sarcoma which he had found in a girl of 4 years of age; it arose primarily from the renal pelvis and from the ureter and showed numerous layers of transversely striated muscular fibers. The latter fact, he has explained by metaplasia of smooth muscle, the former he inferred came from connective tissue of the urinary passages.

Ku (1925) has described a fibromyoma which he saw in a man, 71 years of age. The growth arose from the lower third of the ureter and its muscularis was described as being partly split up. The growth was accounted for by the layer of circular muscle in which a malformation of tissue of the embryo myoma type was assumed to be the point of origin of the growth. In support of the assumption of congenital malformation of tissue, which later leads to a tumor-like development, the simultaneous existence of multiple lipomata and of a pneumonopathy osteoplastica racemosa was deduced.

Lichtheim and Willutzsky have described alveolar sarcomata of the ureter; Target and Heller (1920) have described round cell sarcoma of the ureter (Bachrach). In more recent years, Neuwirth (1928) described a spindle cell sarcoma about the size of a walnut, which he observed in the lower third of the ureter in a man of 51 years of age.

A case, reported by Binder (1921), might be mentioned here; this was not malignant but appeared to belong to this class on account of the structure of the tumor, which

Fig. 8. Microscopic picture taken from Figure 7, showing the papillary carcinomatous parts.

Fig. 9. Photomicrograph showing carcinosarcomatous tissue.

contained different kinds of tissues. It was the case of a woman, 68 years of age, who had a small tumor which closed off the lower end of the left ureter and emanated from the ureteral wall. It was found to be composed of transitional epithelium, smooth muscle, and connective tissue, that is, of all the structural elements of the normal ureteral wall. It was, therefore, assumed by the author to be a hamartoma or hamartoblastoma. The time of origin would have to be placed in an early embryonic stage (70 millimeters long). One could not say, of course, how far the three principal components had increased in the course of their extra-uterine existence, or when they had commenced to proliferate.

Carcinosarcomata of the ureter have, as far as we are aware, not been reported up to the present. Such conditions in the urinary bladder have been described, however, for instance by Krompecher (1808), Leuenberger (1912), Kraft (1921), and Stenius (1925). The last mentioned author submits these tumors to a critical discussion.

For the diagnosis of a growth of carcinosarcoma, it is essential that a mixture of carcinoma and sarcoma should be established in one and the same tumor (Herxheimer). In stating this, Herxheimer suggests three possibilities as to origin: (1) the carcinoma and sarcoma originate at the same time, as a result of the same cause; (2) a carcinoma develops on account of an existing sarcoma; (3) in a carcinoma, the stroma will develop into a sarcoma

Although the tumors belonging to the first group can be compared to real mixed tumors because they admit the assumption of a predisposition in their development, Herxheimer considers that they should be differentiated from the mixed tumors. It is quite clear that external irritation can cause the formation of the tumor, assuming either the presence or absence of predisposition. In this case, the irritation must affect the epithelial elements and the connective tissue in producing the tumor formation. Fundamentally, it would be quite immaterial whether this affected both at the same time or to the same extent.

The second assumption of the genesis of the tumor has found the largest number of adherents, because in most of the carcinosarcomata, the sarcomatous part preponderates. In connection with this, and according to animal experiments, it is quite doubtful whether the quantitative preponderance of one of the components speaks in favor of the sarcoma having appeared prior to the carcinoma. It is a well known fact that in these animal experiments (Apolant and others), it was proved that after repeated implantation of carcinosarcoma in white mice, the sarcomatous part predominated, or, as Herxheimer has put it so appropriately, was able to remain "the victor."

In connection with the third method of the formation of a tumor, it would have to be assumed that the carcinomatous cells we

capable of influencing the stroma toward a sarcomatous proliferation.

We must now ask ourselves the question as to which of the three possibilities of the development of a carcinosarcoma, assumed by Herxheimer, might be applicable to the case described by us.

We believe we are entitled to assume that in our case the formation of the tumor belongs to the first group. Having regard to the comprehensive capability of differentiation of the sarcomatous tissue, which leads to the formation of cartilage, it is probable that we have to deal with a young blastoma which has not yet matured and is therefore still furnished with a far reaching generative power. For the continuance of its existence, a predisposition, conditional to its development (sarcoma germ, retardation in development) might be made responsible.

The fact that there is no indication whatever for an inflammatory causation of the growth (concretion, papillomatosis) also appears to be in favor of a formation of the tumor, congenital in origin. Of course, we are unable to say what led eventually to the proliferation of the tumor in the locally predisposed portion of the ureter wall. The comparatively old age of this patient (71 years) does, in our opinion, not preclude the assumption that there might have been a local predisposition of tissue, reverting back as far as embryonic life. In Ku's case, the patient was 71 years and in Binder's case, 63 years of age.

We should not venture to decide whether the fairly advanced myxomatous component part of the carcinosarcoma, in our case, denotes the immature character of the particular site of the tumor or whether it should be taken as an expression of its degenerative change.

The proof of real mucus in these parts of the tumor, produced by thionine stain, might perhaps support the theory that we are dealing with real myxomatous tissue.

Finally, assuming a local predisposition already present in embryonic life, for the formation of the ureteral tumor, we should not omit to mention that we might have called our tumor a hamartoma; for, as already mentioned, it showed, for no apparent reason, malignant proliferation of the germinal layers of which it was composed.

For information on the subject of scarcity of primary malignant ureteral tumors, we have prepared a statement of the cases of primary malignant neoplasm of the ureter, which were obtained from the postmortem department of the Pathological Institute of the University of Vienna, within a period of 5 years. From July 1, 1924, to June 30, 1929, there was a total of 13,854 autopsies. Among these were 3 cases of ureteral carcinoma and one case of ureteral myoma. In the latter, the still immature cells suggested a myosarcoma. This shows that primary carcinoma of the ureter is represented by 0.022 per cent and primary malignant neoplasma of the ureter in general, by .029 per cent of the postmortem material. During the same time, there were altogether 31 cases of malignant tumor of the urinary passages, of which 24 affected the bladder and were all carcinomata; 3 affected the renal pelvis (2 papillomata and 1 pavement epithelium carcinoma) and, as already mentioned, 4 cases which primarily emanated from the ureter.

If we compare the number of the cases of primary carcinoma of the ureter, which we have found (i.e., 3) with the total number of carcinomata generally (2,124), which were observed during the 5 year period already mentioned, we see that carcinomata of the ureter are represented by 0.14 per cent of the carcinomata. Among the malignant tumors during this period (2,274) malignant ureteral tumors are represented by 0.18 per cent.

Before concluding this treatise, we should like to refer briefly to the pathology of the tumors of the ureter.

The classical symptom triad of tumors of the ureter, is, as we know, renal tumor, hæmaturia, and pain.

The enlargement of the kidney is the most frequent of these symptoms; any growth which narrows down the lumen of the ureter must lead to retention of urine above the obstruction, and finally to a condition of hydro-ureter and hydronephrosis.

Hæmaturia takes the second place in the symptom syndrone. According to Bachrach

it occurs in 45 per cent of all cases, while pain is said to be characteristic in about 33 per cent of the cases observed.

Where the ureteral tumor extends through the ostium into the bladder, the diagnosis, of course, is greatly facilitated by cystoscopy. This is confirmed in the series of Rousselot and Lamon, previously mentioned, in which only 4 cases out of 6 were correctly diagnosed when the tumor of the ureter had penetrated into the bladder.

It is evident that catheterization of the ureter contributes to the diagnosis of an obstructing tumor of the ureter. Ureterography is of a similar importance, but as yet, Bachrach gives these methods only scant praise.

The diagnosis of ureteral tumors was therefore rarely made in the past, and the reports were nearly always restricted to cases under postmortem examination. With increasing use of modern appliances for examination, the number of diagnosed cases rapidly accumulates.

In accordance with the previously mentioned compilation which includes 48 cases of ureteral carcinoma, we see that the correct diagnosis was made in 15 and a tentative diagnosis in 2.

It will be seen also that the first case was diagnosed by Gerstein (1902), while between 1841 and 1922, the diagnosis of ureteral tumor in 32 cases, was made 5 times with certainty and once doubtfully. It was possible to make a diagnosis in the 16 remaining cases, beginning in 1923—in 10 cases with certainty and in 1 case with doubt.

From the description of our case, it is evident that the diagnosis was rendered especially difficult. Of the symptom triad, hæmaturia and renal tumor were present. The cystoscopic examination was a failure because the large tumor of the bladder obstructed every view. Catheterization of the ureter and also ureterography were prevented, as may be imagined, by the tumor of the bladder which was freely movable (compare Figs. 1 A and B). In the suprapubic cystotomy operation which was subsequently carried out, a pedunculated and clearly defined tumor was removed from the bladder and consequently there was no thought of a co-existing tumor of the ureter. The enlargement of the right kidney was therefore thought to be due to another independent neoplasm, and the uræmia, which supervened after the operation, to the presence of a contracted kidney, which was thought to be pyelonephritic.

SUMMARY AND CONCLUSIONS

A carcinosarcoma of the right ureter is described. The tumor arose from approximately the middle of the posterior wall of the ureter. It filled practically the whole ureter as a sausage shaped formation, about the thickness of a finger. It penetrated into the urinary bladder and ended in a round swelling about the size of an apple.

The tumor of the ureter is considered a real carcinosarcoma and the local predisposition of the tissue already present in early embryonic stage, is assumed to have existed, thus causing the subsequent formation of the growth.

Of other malignant growths, about 50 ureteral carcinomata and about 10 tumors of the mesenchyme—most of them malignant growths—have, up to the present time, been described.

The opinion expressed by Israel, Glas, and Player, that carcinomata of the discharging urinary passages could produce metastasis of the type of benign papillomata can not be shared in view of the examinations by Stoerk.

Malignant tumors of the ureter were found in the postmortem material of the Pathological Institute of the University of Vienna, to the extent of 0.029 per cent of the cases. In the total number of observed cases of carcinoma, those of the ureter represent 0.14 per cent; in the total of malignant tumors, 0.18 per cent.

The clinical diagnosis, tumor of the ureter, could not be made on account of the previously described conditions and especially in view of the fact that the hæmaturia and the X-ray picture of the bladder could both be satisfactorily explained by the removal of a perfectly unencumbered, pedunculated, ball shaped tumor of the urinary bladder.

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THE IMPORTANCE OF ROENTGENOGRAPHIC EXAMINATIONS IN ACUTE CASES OF CIRCUMSCRIBED OR DIFFUSE PERITONITIS[1]

ANDERS WESTERBORN, M.D., Upsala, Sweden

As a rule no difficulties are encountered in diagnosing an acute peritonitis and the usual clinical methods of examination are sufficient to diagnose appendicular peritonitis. Occasionally, however, the symptoms are so obscure or unusual, that clinical examination fails to reveal sufficient facts on which to base an exact diagnosis. In such cases, therefore, further means of diagnosis would be of great use. This is especially true in small children and in cases in which the inflammatory process has not subsided after an operation but has caused the formation of intraperitoneal collections of pus. It is natural that in the past in such cases attempts should have been made to improve our methods of diagnosis by the use of the roentgen-ray.

In general it is only during the past few years that the acute abdominal case has attracted more than superficial attention from the radiologist. Laurell was one of the first to make careful study of such cases, and he has reported a series of interesting observations. Reports of only very few cases in which roentgenographic examinations of appendicular peritonitis have been made appear in the literature. In 1927, Laurell and I described a case with multiple intraperitoneal abscesses after appendicitis, which were proved roentgenographically before they could be diagnosed clinically. By this method no less than five abscesses were discovered one after the other and, thanks to immediate incision, the patient was saved. Later, Lundberg and Lilja published reports of 3 cases of similar nature. So far as I am aware no other cases are reported in the medical literature.

In order to get a more detailed idea of the radiological appearances of acute peritonitis, a roentgenologic study was made at the University Hospital of Upsala of a large number of peritoneal cases, also those in which the clinical symptoms were perfectly clear. The observations of Laurell were of great help in diagnosing obscure conditions. More than 100 cases have so far been examined by means of the roentgen-ray. The results of our study will be published later by Laurell and the present writer so that here I will describe only a few of the earlier cases which are of particular interest from the clinical point of view.

METHODS OF ROENTGEN EXAMINATION

The abdomen and thorax are roentgenoscoped and roentgenograms are taken without the aid of contrast enema. In this way a quick examination can be made and the patient does not become unduly tired. If this means does not secure sufficient data and the condition of the patient warrants it, a barium enema is given; the roentgenograms then may reveal valuable data, particularly when an abscess presses against the colon.

The roentgenographic examination is generally carried out with the patient in the supine position; the respiratory movement of the diaphragm is tested, the lungs and pleural sacs are observed, shadows in the abdomen indicating possible exudation are examined and palpated with regard to tenderness to pressure, mobility, etc. Pictures of the abdomen and pelvis are taken with the patient lying on his back and with the rays applied in a vertical direction. When an ileus, a gaseous abscess, or free gas are suspected the respective parts of the abdomen are roentgenographed with the patient lying on his side, back, or, when it can be done, with the patient in a standing position. If the examination is made with the patient in varying positions it has been possible to form an idea also of the displacement of the exudate shadow.

Several conditions have been observed during the roentgen examinations indicating, more or less strongly, the existence of an inflammatory process in the abdomen. These conditions are:

1. An appearance of a more or less pronounced ileus with increased gas and fluid

[1]From the Surgical Clinic, Professor Gunnar Nyström, M.D., Chief, and the Radiological Department, Hugo Laurell, M.D., Chief, of the University Hospital, Upsala.

content and diminished motility of the intestines. Figure 1*a* shows levels as the rays were applied in a horizontal direction.

2. A rounded outline of the meteoristic small intestines with streaks or wedges of exudate between them, or between them and the abdominal wall (Fig. 1*b*, *c*).

3. Fairly large homogeneous shadows in various parts of the abdomen in addition to those caused by the spleen and the urinary bladder. The small intestines, whether filled with fluid or empty, sometimes give homogeneous shadows closely resembling those of an exudate, when they are surrounded by gas filled small or large intestinal coils.

4. Circumscribed gaseous abscesses, e.g., in the right iliac fossa (Fig. 1*e*).

5. Changes in the structure of the abdominal wall. On account of the inflammation, the various fatty layers and particularly the subperitoneal layer show an increased capacity for absorbing the X-rays, so that in this respect they resemble to a certain extent the surrounding tissues. Therefore the subperitoneal fatty layer becomes indistinct or even invisible, so that in the roentgenogram the abdominal wall appears more homogeneous, with blurred or vague contours, and with its interior outline more indistinct than normally (Fig. 1*f*).

6. Changes in intestinal wall and lumen. It is possible to discover an abscess in the vicinity of the large intestine when X-ray examination is made of the colon with a barium enema. The abscess then makes an impression on, or causes a compression of, the intestinal lumen and the wall appears uneven, or jagged in outline: sometimes the mucous membrane stands out in increased relief in the narrowed and sometimes spastically contracted parts of the colon (Fig. 1*g*).

7. Diminished motility or paralysis of the diaphragmatic cupolas.

8. Exudate in the sinus phrenicocostalis on one or both sides (Fig. 1*h*).

9. Disappearance in the roentgenograms of the shadow of the psoas, or, in rare cases, when the inflammation has spread to the retroperitoneal tissues, an unusually distinct reproduction of the vessels in the subcutaneous fatty layer.

Naturally, it is often impossible to diagnose an acute peritonitis solely by means of the roentgen-ray. Here as in other cases the anamnesis and the findings of the clinical and the roentgen examinations must all be taken into consideration and must amplify each other.

REPORT OF CASES AND DISCUSSION OF THE RESULT OF ROENTGEN EXAMINATION

In order to illustrate what has already been said and to show how useful to the surgeon roentgenographic examinations often are, a few of the cases treated in this clinic will be described briefly. The original negatives showed distinctly the roentgen findings but unfortunately some of the details do not show so clearly in the prints. First we present the histories of some adult patients with abscesses clearly visible in the roentgenograms.

CASE 1. No. 2870/1928. Female, aged 18 years. When admitted to the hospital the patient had been ill for 3 days and showed evident symptoms of appendicitis. Temperature was 39 degrees C., pulse 115. Tenderness was noticeable over all the abdomen, particularly on the right side below the navel, where there were signs of a swelling.

Roentgenographic examination. In the right part of the true pelvis and in the right iliac fossa there was seen a homogeneous, or practically homogeneous, shadow indicating an exudate, and connected with the shadow of the bladder, which was emptied before the examination, and the shadow of the uterus (Fig. 2). At operation an abscess was found near the right lateral wall of the pelvis. The abscess was filled with foul smelling pus and reached down to the bottom of the pelvis. No free exudate was present. The perforated appendix was removed and the abscess was drained.

CASE 2. No. 2901/1928. Male, aged 35 years. Patient had been ill for 7 days with general abdominal disturbances. No certain diagnosis could be made clinically. The abdomen was soft, but not tender. Temperature was fluctuating. No palpable swelling was found.

The roentgenographic examination showed that the small intestines were meteoristically distended; further, a streak of exudate (1 to 2 centimeters wide) was visible along the right edge of the pelvis (Fig. 3). The operation verified the roentgenographic findings. On the right, high up in the true pelvis, an appendicular abscess containing foul smelling pus was discovered.

In both of these cases the abscess has thus been diagnosed roentgenographically without the use of a barium enema. In the 2 following

cases such an enema had to be used in order to obtain pictures on which a certain diagnosis could be based.

CASE 3. No. 150/1929. Male, aged 18 years. The patient had been ill for a week with clear symptoms of appendicitis. When admitted his temperature was 40 degrees C. Tenderness was present in the right part of the abdomen but there was no palpable abscess.

Roentgenographic examination disclosed an increased amount of gas in the bowels. The cæcum was displaced toward the left by a homogeneous soft shadow which partly covered the right iliac fossa and partly extended above it. A barium enema was given which disclosed more clearly how the cæcum and the lower part of the ascending colon were displaced medially forward by a shadow from the soft parts, about 10 centimeters in length and 5 centimeters wide. This part of the colon showed an increased contractibility, and the relief picture of the mucous membrane was abnormally rich in folds (Fig. 4). The lumbar spinal column showed a dextroconcave scoliosis and the outline of the psoas was invisible on the right side.

At operation the abscess, the size of a hen's egg, or bigger, and situated behind the cæcum, was drained. Convalescence was normal.

CASE 4. No. 2650/1927. This patient was a physician, 30 years old, who was taken ill October 16 with abdominal pains rather diffuse but localized more to the left than to the right. The pain resembled ordinary stomachache, and was fairly inconstant and not very intensive. The patient himself and the colleague who attended him were both of the opinion that appendicitis was out of the question. The temperature showed great fluctuations. On October 18 it was 38.1 degrees C., on the 20th, 40.1 degrees, and on the 22d, when the patient was admitted to the medical clinic, it was 37.9 degrees. Diagnosis was uncertain also after examination in the medical clinic. The palpation brought out no definite symptoms. There was a certain degree of tenderness both deep down in the appendicular region and in the neighborhood of the left flexure. The possibility of appendicitis could not be excluded; the patient was therefore roentgenographed (Oct. 26).

Roentgenographic examination disclosed a distinctly increased amount of gas in the colon; the small intestines contained gas also but there were no fluid levels. When an enema was given the colon filled up easily to the middle of the ascending part. The proximal half of this filled only with difficulty and, when distended, showed contractions which emptied it almost completely but which did not continue aborally. This part of the intestine filled up and contracted time and again. The cæcum was bent toward the medial line and, together with the ascending colon, it formed a sharp curve which enclosed an elliptical homogeneous shadow indicating an exudate. Orally and medially, this shadow was bordered by gas-filled loops of small intestine. The point of the cæcum was in such a position that it was very likely the shadow covered the point of the appendix. The appendix did not seem to be filled with the enema. The patient said he had the greatest tenderness just over this shadow (Fig. 5).

The patient was now transferred to the surgical clinic, and as the temperature showed an inclination to rise he was operated on. The appendix was not found. The abscess was drained. It was found in the place disclosed by the roentgenograms and was the size of a walnut. The patient died 3 to 4 weeks later from multiple abscesses in the liver. Even at autopsy the appendix was difficult to locate. It was perforated, and was situated medially and partly retrocæcally, and was surrounded by dense fibrous masses.

In this case the diagnosis was almost exclusively based on the roentgenographic findings. These were afterward confirmed by the findings at the operation and postmortem examination. If the possibility of appendicitis had been suspected at an earlier stage, so that the patient could have been roentgenographed a few days earlier, a definite diagnosis would probably have been made then and the life of the patient might have been saved.

In the 4 cases reported, *circumscribed abscesses* of appendicular origin occurred. In 2 of these 4 cases a diagnosis was arrived at without a roentgenographic examination, whereas in the 2 others the abscess was detected only by means of the roentgen-ray. In the first 2 cases a distinct homogeneous shadow was visible in the small pelvis in the very place where the exudate was found. In the 2 latter ones also, the shadow of the inflammatory area could be distinguished in the roentgenogram (near the appendix). In order to strengthen the diagnosis of an abscess, a barium enema was administered. The outline of the cæcal wall then appeared uneven and jagged in the neighborhood of the shadow mentioned and, further, an increased irritability was noticeable in the intestinal wall, thus indicating the existence here of an inflammation. In all 4 cases the small intestines showed increased gas content but no signs of free exudate in the abdomen. The operation verified the roentgenographic findings in every detail in all 4 cases.

The 4 following cases show that the roentgenographic findings may be of great value also in cases of *diffuse peritonitis*.

CASE 5. No. 128/1928. A boy, aged 15 years. The patient had been ill for 2 days with diffuse abdominal pains; no vomiting but vesical tenesmus and macroscopically visible hæmaturia. When the patient was admitted the abdomen was distended and somewhat tense, with diffuse tenderness and a lot of blood in the urine. The roentgenographic examination confirmed the uncertain clinical diagnosis of peritonitis with the following findings: The small intestines were meteoristic with levels of fluid, a diffuse shadow was present in the right flank, the right iliac fossa, and the right side of the true pelvis, where some small gas bubbles were visible. In the left flank a few wedges of exudate were to be seen (Fig. 6). At operation, diffuse and thick exudate was found in the abdomen and, in the right flank, a limited collection of pus reaching down into the true pelvis. It contained foul smelling pus and was due to a gangrenous appendix, which had burst. Patient was dismissed healed.

The clinical diagnosis was peritonitis of uncertain origin. The roentgenographic examination showed that there existed both a diffuse peritonitis and a more limited collection of exudate in the right part of the abdomen, probably from an appendicitis. This diagnosis was confirmed by the operation on every point.

CASE 6. No. 585/1927. A girl, aged 2 years, was admitted to the pediatric clinic after having been ill for a few days with a cough and a feverish cold in the head; the last 24 hours before she was admitted she had vomited and suffered from diarrhœa. She was very weak, breathing was difficult, she ran a high fever, and her eyes were sunken. Many râles and rhonchi were noticed in her left lung. The abdomen was meteoristic and tender, but not particularly so, so that the doctor who attended her concluded that these abdominal symptoms might be due to changes in the lung. The following day the patient was worse. The lungs and abdomen were therefore roentgenographed.

Roentgenographic examination was made. Pneumonia could not be diagnosed with certainty. The diaphragm showed fairly good motility but was placed rather higher than usual on account of the meteorism of the bowels. In the flanks of the abdomen, especially on the right side, a homogeneous shadow was visible, indicating exudate and bordered medially by meteoristic small intestines. The true pelvis was completely filled by a homogeneous shadow (Fig. 7). Roentgenographic diagnosis: abdominal exudate. The operation showed a diffuse streptococcal peritonitis with a large amount of purulent fluid in the abdomen. The small intestines were filled with gas and flushed to a fairly strong red. The patient died the day after the operation.

In this case the tentative diagnosis was lung affection with peritoneal irritation until a roentgenographic examination was undertaken. This did not indicate any changes in the lungs but brought out symptoms of real peritonitis.

As is well known, it is often very difficult with small children, sometimes even impossible, to decide if it is a case of real peritonitis or if the abdominal symptoms present are due to a peritoneal irritation, a peritonism, caused by a pulmonary affection. In these cases the roentgenographic examination is of the very greatest importance. In case of positive roentgenographic findings in the lungs, e.g., a central or beginning pneumonia, the peritonism may be explained and an operation may be avoided. On the other hand, a real peritonitis may occur also when lung symptoms are present, as in the case described above. In this last case the roentgen examination showed the supposed pneumonia to be out of the question and, further, it confirmed the uncertain clinical diagnosis of peritonitis.

In the 2 following cases of diffuse peritonitis we had the opportunity to follow *the post-operative development of the peritoneal exudate* by means of the roentgen-ray.

CASE 7. No. 2811/1927. A girl, aged 8 years. Immediately on her admittance to the clinic November 1, the patient was operated on for diffuse streptococcal peritonitis and the abdomen was washed. After the operation the patient ran a high temperature, her general condition was low, and the abdomen was distended. A roentgenographic examination was made November 8, with the following findings: Exudate in the left flank; excessive exudate in the true pelvis; a mantling exudate in the left pleural cavity. The two diaphragmatic cupolas were dragging. The stomach, colon, and to a less extent the small intestines were meteoristic (Fig. 8). Palpation per rectum showed a swelling in the fossa of Douglas. A large amount of pus escaped when the fornix vaginæ was incised. Drainage tube was inserted.

November 11 the temperature was still high, and the abdomen was distended. Further roentgenographic examination showed that the abdominal exudate had increased in amount as had also the exudate shadow in the left flank. The drainage tube did not seem to drain the abscess in the pelvis, the reason being that it reached too high up and had no lateral holes at the level of the abscess (Fig. 9). The right diaphragmatic cupola stood high, which made the presence of a subphrenic abscess probable. When the drainage tube was readjusted a large amount of pus escaped. After this a subphrenic abscess on the right was drained. Pus was found even in the right flank.

November 12 another roentgenographic examination was made. The exudate in the pelvis had

almost disappeared and the exudate in the left flank had shrunk in size, having apparently sunk into the true pelvis and being thus eliminated. The intestines were still meteoristic (Fig. 10). The right diaphragm was high and paralyzed. Much exudate was noticed in the left pleural cavity. Patient died the following day. Postmortem examination was not permitted.

This case is of special interest. In the first place the roentgenographic symptoms of peritonitis were clear, and we could observe how the exudate collected in the typical places—the true pelvis, the flanks, and the subdiaphragmatic cavities. Further, the roentgenographic examination showed that the drainage tube in the true pelvis did not function in the desired way because it ended too high up in the abdomen and had no lateral holes on a level with the abscess. When the tube had been adjusted in accordance with the roentgenographic indications the whole collection of exudate in the true pelvis disappeared and also the larger part of the exudate in the left flank, which latter must have been connected with the exudate in the pelvis.

CASE 8. No. 2876/1928. The patient, a girl, aged 7 years, was taken ill October 25 with abdominal pains and a mucous diarrhœa. The symptoms continued, and when she was admitted to the clinic after having been ill for a week she was very weak, pale, dry, and had sunken eyes. The temperature was 39.8 degrees C., and the pulse 152. The abdomen was distended, with diffuse tenderness. The diagnosis, peritonitis of enteritic origin, was clear.

Before the operation a short roentgenographic examination (October 31) was made, which showed increased contents of gas in the ventricle and the large and small intestines. The diaphragmatic cupolas showed little or no motility. Exudate was noticed in the flanks and the true pelvis (Fig. 11). The subperitoneal fatty layer was not so distinct as usual. At operation a diffuse streptococcal peritonitis with strongly congested small intestines was found. A large amount of purulent fluid was found in the abdominal cavity, especially in the true pelvis. The abdominal cavity was washed and drained.

At first the patient was very ill, with a high temperature. The temperature went down slowly and the condition improved. The temperature rose on several occasions; on this account a retention of pus was suspected and the patient was roentgenographed several times.

A roentgenologic examination November 21, 3 weeks after the operation, gave the following data: Moderate meteorism of the bowels. The two diaphragmatic cupolas dragged considerably. A small bordering exudate was still to be found in the pleural sacs. The exudate in the pelvis had diminished in size. A further roentgenographic examination December 19 showed an indistinct semilunar shadow of gas under the left diaphragmatic cupola; on this account a colon enema was given. A large amount of barium escaped from the intestine into the cavity under the left diaphragmatic cupola (Fig. 12a). Still signs of exudate remained in the left flank and in the true pelvis. A further roentgenographic examination about 2 months later showed that the hole in the intestine had closed as on this occasion no barium escaped (Fig. 12b). A roentgenographic examination March 4 showed the true pelvis completely filled by the shadow of an exudate (Fig. 13). By this time the exudate could be palpated. The abdomen was now re-examined and there was found in the true pelvis a large abscess and an abscess cavity under the left diaphragmatic cupola. Both these abscesses were connected with the operation wound by means of long fistulæ. The abscesses were drained. Eventually the wounds healed and patient was discharged well.

This case resembles the previous one in many respects. It is a case of diffuse postenteritic peritonitis, which after the operation caused a series of circumscribed abscesses. Only part of the pus escaped directly through the surgical wound. The exudate in the left flank emptied itself spontaneously into the true pelvis, where 5 months after the operation a big abscess was formed, while the flank exudate disappeared. Of greatest interest in this connection is the subphrenic abscess. At the roentgenographic examination December 19, a large amount of contrast mass penetrated from the left colonic flexure up into a big subphrenic abscess cavity. This had apparently been formed at an earlier stage, perforated into the colon, and to a large extent had emptied itself. The drainage into the colon had not been complete, however, and part of the pus found its way to the surgical wound in the right iliac fossa. The long fistula clearly shows this. Neither the flank exudate nor the subphrenic abscess could be diagnosed clinically and were proved only by means of the roentgen-ray. This case of subphrenic abscess, which was diagnosed by means of a barium enema, is probably the first of its kind to be published.

The last 4 cases were of diffuse peritonitis which is easily diagnosed with the roentgen-ray. The clinical diagnosis of peritonitis did

not cause any difficulty in 3 of the cases—in one only was it difficult to make a differential diagnosis. In these as in the first 4 cases the roentgenographic symptoms were: increased gas content in the intestines and homogeneous shadows of exudate between the meteoristic intestines on the one hand and on the other the walls of the abdomen or the pelvis. Such exudate shadows were visible in several places, as for instance in the true pelvis and the flanks, and under the diaphragmatic cupolas. From the flanks they penetrated between the small intestines in the form of streaks or wedges; as a result of this the outlines of the small intestines were more rounded than usual. Further symptoms in these cases have been: pleural exudate, diminished motility of the diaphragm and, in 2 cases, a somewhat more blurred than normal appearance of the abdominal wall in the flank. In Case 5 there also appeared a few small gas bubbles in a circumscribed exudate shadow in the right flank. It is difficult to decide if such gas bubbles are located in the intestinal lumen or outside it in the abdominal cavity. Here one must have recourse to palpation, and the patient must be examined in different positions and with the rays at different angles. Intestinal gas is generally easily displaced while the gas bubbles in a circumscribed abscess remain in about the same place.

These last cases illustrate the fact that the roentgenographic examination brings out points of decisive importance in the diagnosis of peritonitis and, still further, that by repeated roentgenographic examinations after the operation it is possible to follow the development of the peritonitis, fatally or favorably, more closely than can be done by clinical examinations only. Sometimes a collection of exudate can be detected earlier by means of the roentgen-ray than by a clinical examination: in this way it may be possible to make a new incision at an earlier stage than could have been done otherwise.

It is a well known fact that in cases which have been operated on more or less recently it is very difficult to get an exact idea of the abdominal conditions by means of a clinical examination only, as the results of a palpation are bound to be uncertain on account of the surgical wound and the ensuing pain. The more or less pronounced intestinal meteorism which is very common in these cases makes it still more difficult to judge of the real abdominal status. The following cases illustrate the value of the roentgen-ray in these clinically obscure cases.

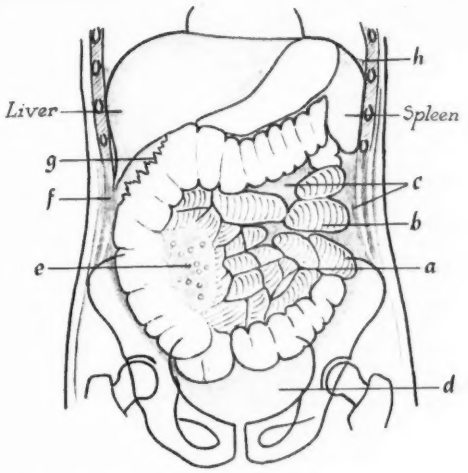


Fig. 1. Skeleton roentgenogram showing *a*, meteoristically distended small intestines; *b*, rounded outline of the intestines; *c*, wedges of exudate between the intestines and exudate in the flanks; *d*, exudate in the pelvis; *e*, gaseous abscess; *f*, non-visibility of the fatty layer of the abdominal wall; *g*, jagged outline of the wall of the colon; *h*, exudate in the sinus phrenicocostalis.

Case 9. No. 242/1929. A girl, aged 16 years, was operated on for diffuse appendicular peritonitis. About a fortnight after the operation an intraperitoneal collection of pus was suspected on account of the fever and the somewhat distended abdomen with a slight diffuse tenderness. No abscess was palpable, however. The roentgenographic examination showed a diffuse shadow covering the whole area of the true pelvis, and the diagnosis was: pelvic abscess (Fig. 14). Not until a week later did this abscess in the true pelvis become definitely palpable. A renewed roentgenographic examination showed that the shadow of the exudate had by now decreased in size but that it had become more dense (Fig. 15). An incision was made and a considerable amount of pus escaped. The roentgenographic examination made a few days later showed that the shadow had disappeared.

In all probability the big pelvic shadow in the first roentgenogram was due chiefly to a small abscess with œdema around it and free

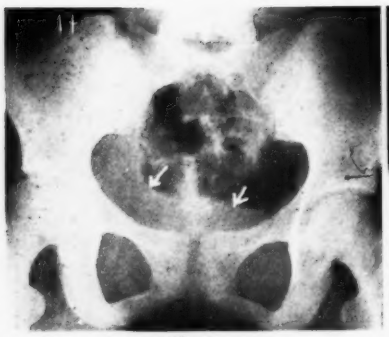


Fig. 2.

Fig. 3.

Fig. 4.

Fig. 2. Case 1. Abscess shadow in the true pelvis (indicated by the arrows).

Fig. 3. Case 2. Abscess shadow in the true pelvis.

Fig. 4. Case 3. Abscess shadow, *a*. Spastic contraction of the ascending colon.

exudate in the pelvis. At the time of the second examination the œdema and the free exudate had decreased while the abscess had grown, so that the shadow visible in the roentgenogram had become smaller but more dense and the abscess palpable.

In the following case also it was possible to prove the existence of a pelvic abscess by means of the roentgen-ray several days before it was clinically palpable.

CASE 10. No. 2511/1927. Woman, aged 30 years, had been operated on for a diffuse appendicular peritonitis and for several weeks after the operation she ran a higher temperature than could be explained by the presence of a thrombosis. The abdomen was soft and no abscess was palpable but the leucocyte count was comparatively high (18,200). The roentgenograms taken 25 days after the operation showed a homogeneous shadow to the left in the pelvis, probably due to an exudate and increased contents of gas in the bowels (Fig. 16). Not until about 2 weeks later was it possible to palpate the abscess; a roentgenographic examination showed that by this time the shadow of the exudate had become larger and more dense. Three days later the abscess was easily felt and it was incised.

The following case is of particular interest because *the roentgenographic examination points to a totally different diagnosis than the clinical one.*

CASE 11. No. 2676/1928. A girl, aged 6 years, was operated on in November, 1927, for appendicular abscess: the appendix was removed and the abscess was drained. The patient was discharged well. During the following year she often complained of abdominal pains. About a year after the first operation she was again admitted to the hospital, having been taken ill with abdominal trouble resembling ordinary colic, vomiting, and fever up to 39 degrees C. When she was admitted to the hospital the abdomen was soft with no palpable swelling. The temperature remained at 38 to 39 degrees while the abdomen grew bigger, and ascites was suspected; therefore a diagnosis of tuberculous peritonitis was made. In order to confirm this diagnosis the abdomen was roentgenographed. No free fluid was present in the abdomen. A circumscribed collection of exudate in the true pelvis was noted. The bowels were meteoristically distended (Fig. 17). The diagnosis of postappendical abscess seemed probable. A week later the abscess became palpable. At the operation, the incision being made above the symphysis, an abscess nearly the size of a goose's egg and filled with foul smelling pus was discovered in the superior strait of the pelvis. The patient was discharged well a month later.

In the 3 last cases it has been possible to prove roentgenographically the existence of an abscess in the pelvis 1 or 2 weeks before it could be diagnosed by palpation. In such cases it is generally a question of abscesses high up in the pelvis, which are difficult to palpate on account of their position, and certain recent limp abscesses which are soft and yielding to the touch. However, intraperitoneal collections of pus in other places may also be discovered by means of the roentgen-ray. This is proved by the following interesting case which had a very unusual course after operation.

CASE 12. No. 2144/1928. A girl, aged 16 years, was operated on August 11 for acute gangrenous appendicitis without peritonitis. The abdomen was

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 5. Case 4. Abscess shadow in the right loin. Spastic contraction of the ascending colon.

Fig. 6. Case 5. The small arrows mark the exudate shadows. The bigger arrow indicates small gas bubbles in the right iliac fossa. Distended intestines.

Fig. 7. Case 6. Meteoristic intestines. Exudate in the flanks and the true pelvis (the late exudate only partly visible on the figure).

closed without drainage. Four days after the operation the patient had a chill and her temperature was 40 degrees C. The throat was flushed. No subjective abdominal symptoms and only such tenderness as might be expected on account of the surgical wound were noticeable.

Roentgenographic examination was undertaken mostly to exclude the possibility of abdominal trouble. On the right in the true pelvis was found a shadow indicating exudate and communicating with another shadow in front of the promontory. The outline of the right psoas was invisible (Fig. 18), and so was the fatty layer of the abdominal wall in the right flank. The diaphragmatic cupolas showed decreased motility. The leucocytes count was 12,400. The following day an operation was done based upon the roentgenographic findings combined with the clinical appearance, the constant fever, and an increasing tenderness. Retrocæcally, paracæcally, and infracæcally was discovered an abscess filled with colon-bacillus smelling pus; it was drained. Three weeks later the temperature rose again. The wound in the abdomen was by now practically healed. No palpable swelling was present. Roentgenographic examination discovered an abscess between the lateral abdominal wall and the ascending colon, the liver, and the right kidney. On the lower side it was bordered by the bent apex of the cæcum and a coil of the small intestine (Fig. 19). The subperitoneal fatty layer was infiltrated where the abscess pressed against the lateral abdominal wall. The part of the colon next to the abscess was meteoristic and showed a peculiar denticulated outline. The gas content of the intestines hardly increased. The right diaphragmatic cupola dragged a little. The operation revealed an abscess the size of a hen's egg in the place indicated and pressing against the ascending colon. The patient was discharged well September 9, but was admitted again with another abscess in the same place. This time the abscess was palpable clinically and an excellent roentgenogram of it was obtained. The abscess was drained, and soon healed; the patient has been quite well since.

It is, of course, very unusual to find an intraperitoneal abscess after an appendicitis of the kind which permits a primary suture, and it is still more remarkable to find no less than three abscesses one after the other, as in this case. It is probable that the cause was a rupture of the appendix ligature and a small leak in the remaining stump of the appendix. At different times fæcal matter was found in the dressing of the wound. The first two abscesses could be diagnosed roentgenographically before there were any definite clinical symptoms.

Naturally, the fact that the shadow of an abdominal abscess was visible in the roentgenograms after an operation for peritonitis does not always mean that an incision must be made and the abscess drained. The abscess contents may be absorbed or may be spontaneously emptied through a drainage canal in the vicinity. What course to take after the discovery of such a shadow of an abscess must be decided in each separate case according to the clinical appearances and development. In this clinic we have had several cases in which such a shadow has

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 8. Case 7. Distended bowels. Shadow from an exudate in the true pelvis. Streaks of exudate in both flanks (chiefly in the left one).

Fig. 9. Same case as in Figure 8. The pelvic abscess has increased in size. The rubber tube does not drain the abscess.

Fig. 10. Case 7. The pelvis exudate has now disappeared (cf. Fig. 9).

been visible in the roentgenogram but has disappeared again after some time without any operation being necessary.

In other forms of peritonitis as well, e.g., in tuberculous peritonitis, the roentgenographic examination may yield valuable decisive factors in arriving at the diagnosis. Such cases are not treated in the present paper, but the reader is referred to the various works by Laurell on the roentgenology of acute abdominal conditions.

It is obvious that in reading the roentgenograms there are various possible *sources of error* to take into consideration. Above all it must be remembered that the shadows of the urinary bladder vary in density with the degree of its distention, and that when only moderately filled and unevenly rounded, the bladder will sometimes give pictures which resemble those of a pelvic exudate. Before the roentgenographic examination is begun the bladder must therefore be emptied, and if the patient cannot empty it completely by himself this must be done by catheterization, and a picture taken afterward. Further, the picture of the small intestines filled with fluid or of an agglomerated omentum often resembles the shadows of an exudate; this is also the case with a mass of empty small intestines surrounded by meteoristic parts of the colon. In order to avoid these and similar stumbling blocks it is necessary, in dubious cases, to take pictures of the patient in various positions and to compare all the roentgenographic findings. If one suspects that a certain shadow indicates an exudate, other special signs of abdominal inflammation should be sought for, as for instance spasticity, state of the intestine, paralysis of the diaphragm, exudate in the sinus phrenicocostalis, or the invisibility of the fatty layers in the abdominal wall, etc.; all these radiological symptoms must be compared with the anamnesis and the clinical findings.

By means of these roentgenographic signs typical of an inflammation it is also possible to distinguish between an exudate and other collections of fluid in the abdomen, e.g., intraperitoneal hæmorrhage. It must be remembered, however, that a small pleural exudate can be found also in cases of hæmorrhage in the upper part of the abdomen.

The roentgenographic examination itself is very simple, as is evident from what has

Fig. 11.

Fig. 12. *a* *b*

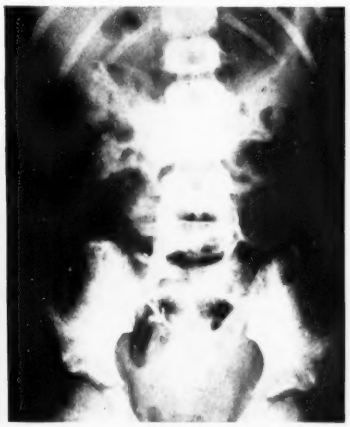


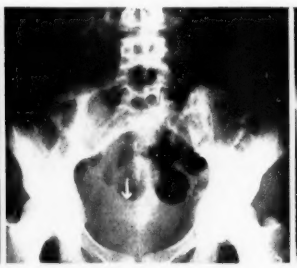
Fig. 13.

Fig. 11. Case 8. Distended bowels. Exudate in the pelvis and the flanks (chiefly in the right one).

Fig. 12. Case 8. A, Subphrenic abscess filled with barium from a colon enema. B, Two months later. The fistula of the colon is healed. No barium is to be seen under the diaphragmatic cupolas.

Fig. 13. Case 8. True pelvis entirely filled by a homogeneous shadow from an abscess.

Fig. 14.



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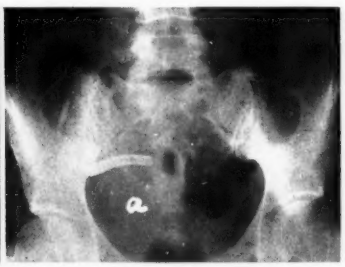

Fig. 16.

Fig. 14. Case 9. Big shadow of an abscess in the pelvis.

Fig. 15. Same case as Figure 14 X-rayed a week later. The shadow of the exudate is smaller but denser.

Fig. 16. Case 10. *a*, Abscess shadow to the right in the true pelvis.

already been said. It need not tire the patient; it can be carried out without much loss of time, e.g., while the operating room is made ready for the operation. The interpretation of the roentgenograms is sometimes rather difficult, it is true, but in many cases the plates can be read by any medical man with a little training even if he has not specialized in roentgenology.

It is quite possible that in some of the cases described the roentgenographic examination has saved the life of the patient. At all events, many of the patients have been operated on at a considerably earlier stage, thanks to such examination, than would have been possible otherwise. In a case of peritonitis this is naturally of the greatest importance. Further, in dubious cases especially when it is necessary to avoid an operation if possible, e.g., in small children or in very old persons, it is very valuable for the operator to be able to confirm his diagnosis before the operation by means of roentgen examination or to exclude peritonitis on the strength of negative roentgenographic findings. The last consideration is a point of the utmost importance. It often happens that laparotomy is done because the possibility of peritonitis cannot be excluded solely on the strength of the clinical findings, but opera-

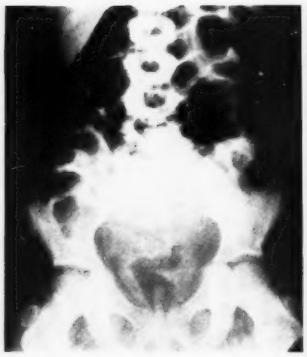

Fig. 17.

Fig. 18.

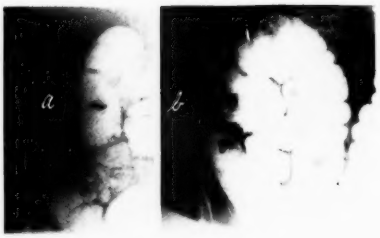

Fig. 19.

Fig. 17. Case 11. Meteoristic bowels. Much exudate in the pelvis.

Fig. 18. Case 12. *a*, Abscess in the right flank with impression and jagged contour of the colon wall.

Fig. 19. Case 12. *a*, Abscess in the right flank with jagged contour of the colon wall. *b*, Some weeks later. The abscess has disappeared and the wall of the colon is normal.

tions fail to disclose peritonitis. Clinical symptoms resembling those of peritonitis may arise from many causes: beginning pleural affection, cardiac insufficiency, or an irritation of the peritoneum from the retroperitoneal organs, etc. An exploratory laparotomy may greatly complicate the prognosis in these cases. By the more extensive use of roentgen examination it will, of course, be possible to make definite the diagnosis in more cases of peritonitis, and this will mean that the number of cases on which laparotomy is done on an uncertain diagnosis and at operation proved to be negative for peritonitis will considerably decrease. Thus, at the University Hospital of Upsala we have already profited by using the roentgen examination, for thanks to negative roentgenographic findings in several cases with regard to peritonitis no operation was done.

It is my opinion that the use of roentgen-ray in examining patients with acute abdominal conditions will prove of the greatest importance in the near future in making diagnosis as to free and circumscribed acute peritonitis.

SUMMARY

In order to investigate the roentgenologic picture of acute peritonitis, a large number of peritoneal cases have been radiographed in the University Hospital of Upsala. Changes quite characteristic of acute peritonitis were found The author describes the technique used, interprets the roentgenograms, and tells of the most important causes of error in studying the pictures. He reports some cases in which the radiological examination has given valuable information in the diagnosis of acute diffuse or localized peritonitis. The method has been of especial value in confirming doubtful clinical diagnoses in small children and as a means of discovering postoperative intraperitoneal abscesses. In several cases such abscesses have been precisely located much earlier through roentgenographic study than would have been possible through clinical examination only.

The present paper is based on a lecture delivered at the meeting of the Surgical Association of Sweden in Stockholm, November, 1928, and at the Congress of the Surgical Association of Germany in Berlin, April, 1929.

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"LYMPHOSARCOMA" OF THE NECK[1]

JOHN W. SPIES, M.D., NEW HAVEN, CONNECTICUT
The Department of Surgery, Yale University School of Medicine

THE object of this study is (1) to call attention to the existence of certain types of carcinomata which may be readily confused with the so-called "lymphosarcomata" of the cervical lymph nodes, and (2) to emphasize the need of a clinicopathological analysis of a larger number of cases than can ordinarily be produced by one institution, thus the necessity for sending all available material to the Lymphoid Tumor Registry, Army Medical Museum, Washington, D. C.

No cases known to be still living were included in the present series. In order to secure uniformity a further restriction was made in that each case must have had a definite histological diagnosis from the department of pathology of the Memorial Hospital. Pathologists vary in their ability and criteria. Therefore, outside diagnoses have not been accepted. This narrow, arbitrary selection of material seems justified because of the difficulties in diagnosis which every pathologist (no matter who he is) apparently encounters in the lymphoid group of tumors. Indeed, it may be exceedingly hard to differentiate an inflammatory process from a neoplastic one. Typical features may be readily detected, but atypical tissue responses may "plague the soul" of the most competent microscopist, and oftentimes he may not be able to render a clear cut decision. Consequently, the author hopes that he will not be misunderstood when he casts aside diagnoses which he has had no opportunity of checking or which have been made by persons with whose qualifications he is unacquainted. Only 50 cases were found which met these requirements. After a careful restudy of the histological structure of these 50 cases the following tentative classification was employed.

No classification of lymphoid tumors is wholly satisfactory. Until the etiology is discovered, the histogenetic one employed by Ewing (4) is the most logical. On account of the disappointing state of affairs everybody interested in this group of neoplasms should send specimens and data to the Lymphoid Tumor Registry, Army Medical Museum, Washington, D. C., so that ultimately a large collection will be available for study. This will stimulate interest and may somewhat relieve the chaos of today, even though future experimental studies should happily produce an etiological classification.

In the past the supposed futility of subdividing the lymphoid tumors was evidently recognized by Mallory. He employed the term lymphoblastoma, to include lymphocytoma, lymphoma, lymphosarcoma, pseudoleukæmia, lymphatic leukæmia, and Hodgkin's disease. He defined a lymphoblastoma as being "a tumor of mesenchymal origin of which the cells tend to differentiate into lymphocytes, that is, into cells of the lymphocyte series." This general point of view may have been perfectly justified and may continue to be so until the accuracy and value of subdivision is established. This may be hoped for by the application of ideas gained in the analysis of a small series only if such conceptions can furnish clues for the study of large amounts of material with the accompanying data. For this latter we need a tumor registry.

The series upon which this study is based does not contain a sufficient number of cases to be of great statistical importance. *The classification employed is not recommended for lymphoid tumors.* It merely affords a convenient way to study a group of tumors that have been classified in the hospital files as lymphosarcoma of the neck.

A few explanations will be given concerning the grouping used in this study. The reticulum and the lymphocytic cell of the lymph gland may conceivably give rise to a separate neoplastic process. In some cases this distinction seems well preserved and readily detected. In others one may apparently be confronted with both types of cells participating in the new-growth. Even though Hodgkin's disease is improbable, one may occasionally

[1] From the Department of Pathology of Cornell University Medical College and the Memorial Hospital, New York.

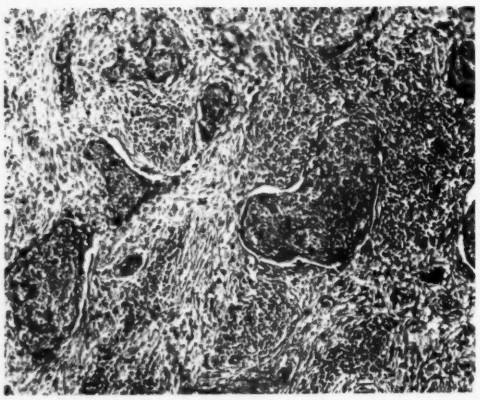
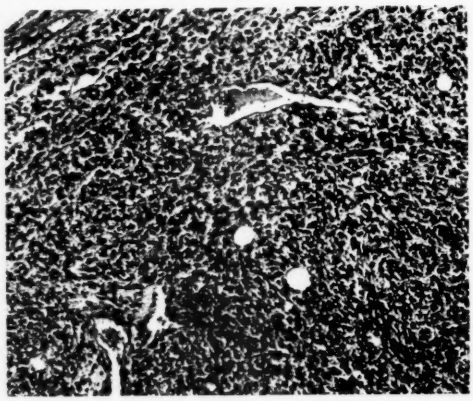


Fig. 1.



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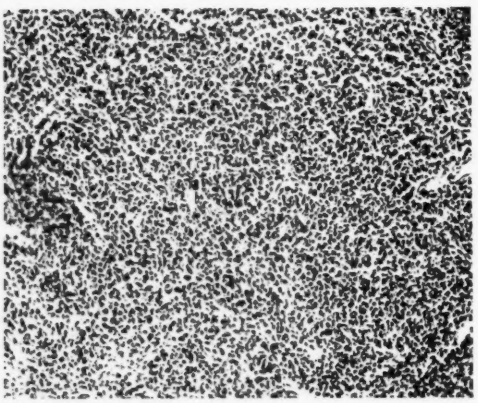

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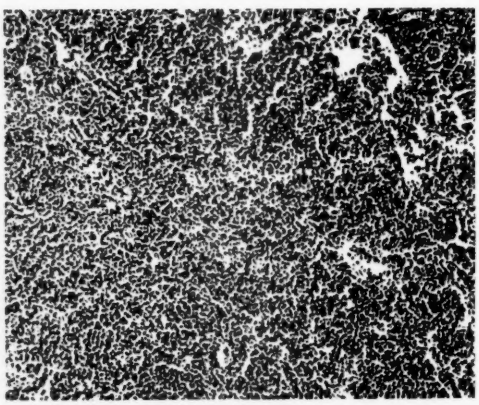

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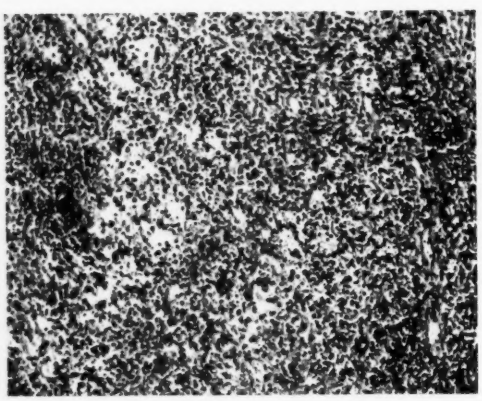

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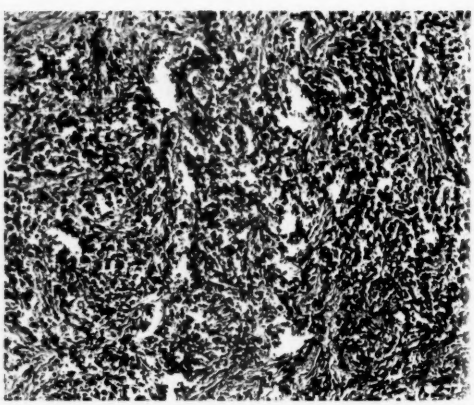

Fig. 6.

(Legend on opposite page.)

TABLE I.—CLASSIFICATION

	Cases	Percentage
Lymphosarcoma	33	66
Reticulum cell type	21	42
Lymphocyte cell type	2	4
Atypical cell type	10	20
Lymphogranuloma	5	10
Chronic non-specific	4	8
Probable Hodgkin's	1	2
Carcinoma	5	10
Transitional cell	2	4
Lympho-epithelioma	3	6
Unclassified		
Slides not available for restudy	7	14
Total	50	100

see large multinucleated cells. When one has these admixtures, there is added an "atypical" feature to what is otherwise a straightforward case of lymphosarcoma. Also, inflammatory reactions of various types and degrees may force one to attach the label of "atypical."

The true neoplasms (arising from easily identified parent cells and uncomplicated by extraneous elements) present an easier histological diagnostic problem than do those processes which exhibit some of the features of chronic inflammation. In this latter group belong the malignant lymphogranulomata. These have the power of unrestrained growth associated with the picture of chronic inflammation. Perhaps the best known of these is Hodgkin's disease. Even this interesting form (which has long been suspected of being some atypical reaction to tuberculosis) is often very difficult to diagnose. Most other malignant lymphogranulomata have evaded all efforts to subdivide them satisfactorily on a histological basis.

In this study the term "lymphogranuloma" is used to designate tumors which may present any, or all, of the following features: fibrosis, plasma cells, eosinophiles, and mononuclear cells of various types but which do not present the typical picture of Hodgkin's disease or of "lymphosarcoma." Four of these were found. Another was sufficiently typical of Hodgkin's disease to place it in a separate group.

CARCINOMA SIMULATING LYMPHOID TUMORS

In 1921, Schmincke, also Regaud, Reverchon and Coutard, drew attention to malignant tumors occurring in the nasopharynx, region of the tonsil, and the base of the tongue, in which the histology suggested that of an anaplastic carcinoma associated with an abundance of lymphocytes. The term "lympho-epithelioma" was applied. In 1922, New described a syndrome in which 51 of 79 cases of malignant tumors of the nasopharynx presented cervical lymphadenomegaly as the first clinical evidence of the disease. In 18 of the 51 patients the discovery of the primary nasopharyngeal tumor was not made until after the operation upon the lymph nodes of the neck. In this group of 79 cases there were 34 carcinomata, 33 lymphosarcomata, 7 in which the type was undetermined, and 5 had no histological examination. In 1925, and again in 1927, Quick and Cutler produced evidence to show that about 10 per cent of the intra-oral carcinomata are very radiosensitive and that often the first manifestation of the disease is the enlargement of the cervical lymph nodes. Their sections appeared to be those coming from very anaplastic epidermoid carcinomata, and the association of lymphocytes was slight or absent. These last authors called attention to the likelihood of distant internal metastases,

Fig. 1. Lympho-epithelioma. Large, well defined groups of cells present an epithelioid arrangement. Lying within the dense fibrous stroma are other cells of the same character but which are more loosely disposed and which carry a sparse admixture of lymphocytes.

Fig. 2. Transitional cell epidermoid carcinoma. The nuclei are dark. Syncytial masses are absent. There are no accompanying lymphocytes. The cells are not densely packed. The vessels in the upper and lower part of the figure contain coagulated blood and not tumor cells.

Fig. 3. Reticulum cell lymphosarcoma. Most of the cells resemble the reticulum cells seen in lymph nodes. They vary in shape and size but are sufficiently typical to warrant the diagnosis. Lymphocytes are infrequent and do not appear to be participating in the tumor process.

Fig. 4. Lymphocytic cell lymphosarcoma. These cells cannot be differentiated histologically from lymphocytes. The morphology combined with the features of unrestrained growth give the diagnosis.

Fig. 5. Chronic lymphogranuloma. In addition to cells of neoplastic character, there are lymphocytes, plasma cells, large endothelial leucocytes, somewhat amorphous connective tissue, and a few polymorphonuclear neutrophilic leucocytes.

Fig. 6. Atypical lymphosarcoma. There is dense, abundant fibrous tissue, suggesting invasion of extraneous tissue rather than a supporting stroma. The tumor cells lie within this and in some places line large tissue spaces. They are often of giant size and possess several nuclei. There is no clue as to their origin. Lymphocytes are few. There are no definite polymorphonuclear leucocytes. One is unable to classify this process.

whereas in squamous carcinoma arising from the same sites it is unusual to find visceral deposits. Jovin reported the occurrence of distant metastases to the bones and internal viscera. In 1929, Ewing reviewed the subject of lympho-epithelioma, and concluded that the "exact scope is not yet clear." He stated that the diagnosis must be made on structure rather than on clinical data. His study of a group (200 cases) of tumors of the base of the tongue and the tonsil revealed that 72 per cent were squamous carcinoma; 12 per cent were of the transitional cell type of epidermoid carcinoma; 9 per cent were lymphosarcomata; 4 per cent were lympho-epitheliomata; and 3 per cent could not be classified. In a collection of nasopharyngeal neoplasms (100 cases), the same author found that squamous carcinoma accounted for 30 per cent; 37 per cent were transitional cell epidermoid carcinomata; 15 per cent were lymphosarcomata; 11 per cent were lympho-epitheliomata; 3 per cent were malignant adenomata; and 4 per cent were adenoid cystic epitheliomata. In 1923, Crowe and Baylor were of the opinion that it was sometimes impossible to differentiate histologically between sarcoma and carcinoma and that a sufficient accumulation of clinical data was valuable. They listed 16 cases as carcinomata, 26 as sarcomata, 5 as angiosarcomata, 3 as myxosarcomata, 10 as lymphosarcomata, and 8 as angiomata. This would make a total of 68 cases and give approximately 23 per cent for carcinomata and 14 per cent for lymphosarcomata. If one eliminates the 8 cases of angiomata, leaving only malignant tumors, one arrives at about 27 per cent for carcinomata and 16 per cent for the lymphosarcomata. One may compare these figures with Ewing's 48 per cent for epidermoid carcinomata and 15 per cent for lymphosarcomata; also, with New's about 42 per cent for carcinomata of all types and about 44 per cent for lymphosarcomata. In 1929, Cutler made a careful study and drew the conclusion that although transitional cell epidermoid carcinomata and lympho-epitheliomata were separate histological entities, they might not be so differentiated clinically. He also stated that in some cases these epithelial tumors might be confused with lymphosarcomata, both histologically and clinically. The lymphoid tumors exhibited a shorter course, gave earlier constitutional symptoms, and more often produced bilateral cervical lymphoadenomegaly especially in the first stage of the disease. He believed that the treatment is the same for lymphosarcomata as for carcinomata of a radiosensitive type. From this he reasoned that the separation from a practical standpoint is not very important.

The articles already referred to are cited in order to substantiate the claim that there are several varieties of malignant neoplasms which exhibit themselves mainly in the cervical lymph nodes, and that within these there is a well recognized group of carcinomata which may be readily confused, both histologically and clinically, with certain types of lymphoid tumors. A restudy of the data and material now available in hospital files may reveal, as it has in this study, that carcinomata constitute an appreciable percentage of the cases filed under "lymphoid tumors."

The 7 cases listed under the heading of "unclassified" are those in which a biopsy was taken outside of the General Memorial Hospital but which unfortunately had to be returned to the sender. Thus the diagnosis was confirmed, but the slides are not now available for restudy. All attempts to secure them have failed. From Table I, one may assume that these 7 cases might contain tumors of a different histological structure even though they have been passed as lymphosarcomata. Some might even be carcinomata.

With these explanations in mind and with the restatement that *the present writer is not presenting a tumor classification* but is attempting to separate certain histological types discovered within the hospital files as lymphosarcoma of the neck, the reader's attention is invited to Table I. This reveals that the lymphosarcomata constitute 66 per cent; the lymphogranulomata, 10 per cent; the carcinomata, 10 per cent; and the unclassified (because of no slides available for restudy), 14 per cent. Within the lymphosarcomata the reticulum cell type accounts for 42 per cent; the lymphocyte cell type, 4 per cent; and the atypical cell type, 20 per cent. As an interesting coincidence the carcinomata form 10 per

TABLE II.—AVERAGE AGE ON ADMISSION TO THE HOSPITAL

	Years
Reticulum cell lymphosarcoma	44
Atypical cell lymphosarcoma	38
Chronic lymphogranuloma	53
Average	45

TABLE III.—AGE BY DECADES—PERCENTAGE

	1	2	3	4	5	6	7
Reticulum cell lymphosarcoma	..	14	14	14	14	20	24
Atypical cell lymphosarcoma	..	10	30	10	20	30	..
Chronic lymphogranuloma	..	..	..	..	50	25	25
Average percentage	..	8	15	8	28	25	16

cent of the entire group. This is the figure that Quick and Cutler gave as to the relative frequency of transitional cell epidermoid carcinoma among intra-oral carcinomata as a whole. One notes, too, that in New's analysis of malignant tumors of the nasopharynx 11 per cent were of an undetermined type. The one case of probable Hodgkin's disease had metastases to the spinal column as shown roentgenologically and clinically.

CLINICOPATHOLOGICAL ANALYSIS

Although it is realized that the cases are too few in number to assume any statistical importance, it is hoped that a few interesting points may be elicited. But among the lymphoid tumors only the reticulum cell type, the atypical cell type, and the chronic granulomata comprise a sufficient number to justify such an attempt. The carcinomata may be best studied in the references mentioned.

In a recent paper Elkin has reported his study on 41 primary neoplasms of the lymph nodes. He considered 15 of these to be lymphosarcomata and gave the average age of his patients as 33 years. The average age of Cutler's series of 9 epidermoid carcinoma cases was about 51 years. In Table II, the average is 45 years. The reticulum cell group lies between the 2 other groups, having 44 years for its average.

The lymphogranulomata occurred in this series at a distinctly later age than did the lymphosarcomata.

No granulomata occurred in males. In the sarcomata the females were in the minority.

TABLE IV.—SEX—PERCENTAGE

	Males	Females
Reticulum cell lymphosarcoma	57	43
Atypical cell lymphosarcoma	60	40
Chronic lymphogranuloma	..	100
Average percentage	39	61

TABLE V.—SIDE OF NECK IN WHICH THERE WERE NODES—PERCENTAGE

	Right	Left	Both	Not stated
Reticulum cell lymphosarcoma	14	14	48	24
Atypical cell lymphosarcoma	20	20	50	10
Chronic lymphogranuloma	25	..	75	..
Average percentage	20	11	58	11

TABLE VI.—EXTERNAL SITES—IN RELATION TO THE NECK—PERCENTAGE

	Above	Below	Neck alone	Above and below
Reticulum cell lymphosarcoma	38	10	19	33
Atypical cell lymphosarcoma	20	20	..	60
Chronic lymphogranuloma	25	..	..	75
Average percentage	28	10	6	56

In the granulomata the left side alone was not involved. In all three types bilateral involvement was the rule. It would seem that the involvement of both sides of the neck is more frequent in the lymphoid tumors than in the transitional cell epidermoid carcinomata, although it is well known that it may occur in the latter.

The term "external sites" in Table VI is employed in the sense of including all superficial regions and in addition the mouth, nose, and pharynx. The term does not include the internal viscera. It is to be remembered that all cases in this series had involvement of the cervical lymph nodes.

None of the granulomata were found to be confined to the neck alone. Seventy-five per cent of them had lesions both below and above the neck. Likewise the atypical lymphosarcomata were never found in the neck alone, and the majority were both below and above the neck. If one compares the findings in Table VI with the duration of symptoms (Table VII), one is struck with the fact that the duration of life varies directly with the amount of external involvement. This suggests that the amount of external involvement varies directly with the amount of internal

TABLE VII.—DURATION OF SYMPTOMS IN RELATION TO MEMORIAL HOSPITAL ADMISSION

	Months before	Months after	Total months
Reticulum cell lymphosarcoma	8	13	21
Atypical cell lymphosarcoma	8	8	16
Chronic lymphogranuloma	4	7	11
Average	7	9	16

TABLE VIII.—GENERAL CONDITION UPON HOSPITAL ADMISSION—PERCENTAGE

	Poor	Fair	Good	Not stated
Reticulum cell lymphosarcoma	24	10	66	..
Atypical cell lymphosarcoma	30	10	50	10
Chronic lymphogranuloma	100	..	..	..
Average	51	7	39	3

visceral involvement. This can be determined only by a large autopsy series. Minot and Isaacs (8) state that "data at hand suggest that if abnormal-sized nodes are searched for they will be found in cases with lymphoblastoma, particularly involving internal structures more often than is suggested by the figures given." This statement coming from a person of Minot's wide experience must be significant. It is hoped that the analysis of a tremendous series of carefully recorded cases, as one may expect eventually to find in the Lymphoid Tumor Registry, will give us the correct prognostic value of external involvement.

The tumor bearing sites *below the neck* were the breasts, axillary nodes, inguinal nodes, buttock, lower limbs, etc. *Above the neck* the scalp was frequently the seat of the neoplastic process, but it was striking how often the pharynx seemed to be the primary focus.

In none of Cutler's cases is there mention of superficial lesions other than in the neck. Apparently his cases with carcinoma metastatic in the cervical lymph nodes had involvement of the internal viscera without further manifestation upon the superficial areas of the body. Perhaps this can be employed as a point in differential diagnosis between certain epithelial and lymphoid tumors when they present themselves as a lymphadenomegaly.

The study of *internal sites* must be left for an autopsy or exploratory series and will not be undertaken at the present time.

Apparently the total duration of symptoms is related to the type of disease rather than to

TABLE IX.—TREATMENTS BEFORE COMING TO THE HOSPITAL*

	Surgery	X-ray	Radium	Local applications	Ultraviolet	No treatment cases
Reticulum cell lymphosarcoma	3	1	.	1	.	16
Atypical cell lymphosarcoma	3	1	.	1	1	4
Chronic lymphogranuloma	1	1	1	.	.	1
Average	7	3	1	2	1	21

*Not on a percentage basis.

the method of treatment, for (see Tables IX and X) the therapy applied in the various cases was along the same general lines. All the patients died.

By comparing Table VIII with Table VII one may infer that the general condition of the patient, when he presented himself at the hospital, was inversely proportional to the duration of the symptoms. In the granulomata the general condition was poor in 100 per cent of the patients, and yet the duration of symptoms before coming to the hospital was one-half of that in the 2 other groups. It may well be that the more ravaging the disease the earlier is medical advice sought and the more likely is the physician led to send the sufferer into the hospital.

Table IX illustrates the variety and number of treatments that the patients had before coming to the hospital. This is not on a percentage basis, for it is to be remembered that perhaps one patient might have several sorts of therapy and another might have only one. Sixteen of the twenty-one reticulum cell cases had no treatment. This holds true in 4 of the 10 atypical cell and in 1 out of 4 of the granuloma patients. Thus most of the cases were subjected to no therapy whatsoever.

After admission to the hospital, radium was the most frequently employed agent and X-ray came second. Surgery, except to procure biopsies, was not resorted to. Many of the X-ray treatments were administered with the low voltage machine before the advent of the high voltage apparatus. As a rule the radium was applied in large doses from a distance. In three instances Coley's toxins were resorted to.

In the great majority of cases the size of the tumors was markedly reduced. By compar-

TABLE X.—TREATMENTS AFTER COMING TO THE HOSPITAL*

	Radium	X-ray	Coley's toxins
Reticulum cell lymphosarcoma	16	5	3
Atypical cell lymphosarcoma	6	8	.
Chronic lymphogranuloma	3	3	.
Average	25	16	3

*Not on percentage basis.

TABLE XI.—SUBSEQUENT COURSE—PERCENTAGE

	Regression	No regression	Not stated
Reticulum cell lymphosarcoma	71	5	24
Atypical cell lymphosarcoma	90	.	10
Chronic lymphogranuloma	100	.	..
Average percentage	87	2	11

TABLE XII.—FINAL RESULTS—PERCENTAGE

	Dead	Lost track of
Reticulum cell lymphosarcoma	81	19
Atypical cell lymphosarcoma	80	20
Chronic lymphogranuloma	100	..
Average percentage	87	13

ing Table XI with Tables VII and XII, one finds that the more malignant the process the better was the initial response. Pursuing this thought further one might assume that in a given case the amount of regression of the masses varies inversely with the length of life remaining to the sick person. In other words, may one not say that the better the response to radiation the poorer is the prognosis so far as duration of life is concerned? There is no doubt but that the patients were made more comfortable for a time, and from the standpoint of symptomatic palliation one is impressed with the beneficial effects. This coincides with the observations made by Minot and Isaacs (8).

One may safely assume that the mortality was 100 per cent in each group. Everybody that was lost track of was in very poor condition when last seen. This statement is further supported by the fact that in the current files for lymphosarcoma of the neck in the Memorial Hospital there is no living patient of more than 3 year's standing in which the diagnosis was made or confirmed by its own department of pathology. This excludes those cases diagnosed in other institutions unless the section was later seen by the pathologist of the Memorial Hospital and adequately confirmed. Of course, in any large series one may find cases living for more than 3 years after the beginning of symptoms, but as Minot has so well expressed it, we do not know but that those are the cases which nature intended to live a long time. It would seem that our treatments have no proved effect on the duration of life. Cases extending beyond the 3 year period must be rare if the diagnosis has been confirmed by a competent and conservative pathologist.

All cases in this series had biopsies. In 7 of the 21 cases of reticulum cell lymphosarcoma, the patients were subjected to biopsies before coming to the Memorial Hospital. In 2 of these there were incisions into the pharyngeal mass. One of these lived only 6 months and the other 8 months from onset of symptoms. This is much lower than the average (21 months) for the reticulum cell group. But if one computes the average of the 7 cases which had biopsies before coming to the hospital, including the 2 with incisions into the mass, the average duration of life is found to be 24 months. Although incisions *into* lymphoid tumors may be unjustifiable and dangerous, it does not seem that one is justified in condemning properly taken biopsies without adequate supporting data. Biopsies taken early in the disease as compared with those secured at a later stage seem to have no deleterious influence.

A few interesting features will be noted. Two women had definite involvement of the breasts. They lived a very short time. One patient had repeated operations over a period of 10 years in order to remove recurrent "tumors" in the oral pharynx. Finally she had definite, but atypical, lymphosarcoma at the base of the tongue. One case presented a nodular liver and jaundice. Splenomegaly was observed in one individual.

SUMMARY

A tentative classification has been adopted but only in order to make the present study. In general it conforms to that of Ewing's; i.e., where possible, being based on histogenesis. In

the past decade there has accumulated sufficient evidence to warrant the statement that certain carcinomata metastatic to the cervical lymph nodes may simulate lymphoid tumors both histologically and clinically. Of these there seem to be two groups as far as structure goes. One has been designated "lymphoepitheliomata" by the French school, and the other has been called "transitional cell epidermoid carcinomata" by some American writers. Ordinarily the former carries with it a generous admixture of lymphocytes, and the epithelial cells (often in syncytial masses) are larger and paler than in the latter group. Both are radiosensitive, have a very small primary tumor (in the nose, pharynx, or mouth), metastasize to the cervical lymph glands (that being ordinarily the first evidence of disease) and thence to the bones and internal parts of the body. The reason for calling attention to these carcinomata is because in the present study they have been found to constitute 10 per cent of the cases filed as "lymphosarcoma" of the neck.

The difficult problems presented in the histological diagnosis of lymphoid tumors have been partly pointed out. The solvability presents more obstacles in the so-called lymphogranulomata than in the lymphosarcomata. The former have a more complicated structure because they may appear to be chronic inflammatory reactions and yet present features of autonomous growth.

The author believes that the present chaos existing in the group of lymphoid tumors can best be relieved by a general patronage of the Lymphoid Tumor Registry, Army Medical Museum, Washington, D. C.

A clinicopathological analysis is made on a small, restricted group of tumors in the hope of demonstrating subgroups. It remains to be seen whether these will hold on a large number of lymphoid tumors appearing in various parts of the body. On account of the relative frequency in the present series, the reticulum cell lymphosarcoma, the atypical cell lymphosarcoma, and the chronic lymphogranuloma have been selected for the analysis (for their description see explanation of Table I).

The granulomata occurred in older people, were in women, and presented bilateral involvement of the lymph nodes of the neck in 75 per cent of the cases. Differences were also noted between the other two groups.

In the various classes of tumors the more extensive the external involvement the shorter was the duration of life. Probably this is because the external involvement varies directly with the internal involvement, and this point should be determined in a large autopsy series. At any rate, the amount of external involvement is easily ascertained and seems to have a certain prognostic value. As a differential point between carcinomata (see above) and the lymphoid tumors, evidence of the disease in superficial parts of the body, other than the neck, would be in favor of the lymphoid neoplasm, and it appears that bilateral involvement of the cervical lymph nodes is less common in the carcinomata. Judging from the available literature, the carcinomata tend to metastasize internally without further external manifestations.

A study of the lymphoid tumors indicates that the progress of the disease is related to the type of cell rather than to the type of treatment instituted. The reticulum cell, the atypical cell, and the granuloma taken as separate groups show 21, 16, and 11 months, respectively, as an average total duration of life from the onset of symptoms. Most of the patients had no treatment before coming to the hospital other than the taking of biopsies and the desultory giving of radiation. After hospital admission biopsies were taken on all cases in which sections had not been secured outside of the hospital or where these were not available for confirmation. Otherwise surgery was not resorted to. Radiation was instituted in all the therapeutic regimens. Large doses of radium applied from a distance was employed more frequently than the X-ray.

In addition to the differences enumerated, the reticulum cell lymphosarcoma in comparison with the chronic lymphogranuloma showed less external involvement, better general condition upon admission, and less regression in the size of the tumors treated. Between the extreme limits of these two groups lay the atypical lymphosarcoma. As a general thing the more malignant the cell type, better was the initial tumor response to

the radiation, and shorter was the duration of life. This leads one to assume that the more prompt and the greater the reduction of the radiated tumor the less time will the patient live. As has been emphasized by Minot and Isaacs, it is very doubtful if the treatment of lymphoid tumors does more than to make the patients more comfortable during the time that they live.

In all cases followed to the end (Table XII), there was a probable mortality of 100 per cent. In the few that were finally lost track of, the general condition of the patients leaves no doubt that they shortly thereafter succumbed to the disease. Furthermore, in the current files of the Memorial Hospital (at the time this data was collected) there could be found no undoubted case (this means an adequately confirmed histological diagnosis in the hospital's own department of pathology) of more than 3 years' standing. This is a gloomy outlook but seems warranted at the present time. However, one must recognize that there is the occasional case which may live longer, but this is probably due to the natural history of the malady in that particular individual rather than to the institution of treatment.

In the reticulum cell lymphosarcoma group, the average total duration of life in 7 patients having biopsies before coming to the hospital was slightly more than in the 14 remaining who were subjected to the same process after coming to the hospital. In addition to this meager bit of evidence, one could never deduce from any of the records studied in the entire series that the taking of biopsy speeded the progress of the disease.

As a matter of record a few interesting features have been set down.

CONCLUSIONS

1. In cervical lymphadenomegaly one finds a small number of carcinomata which clinically and histologically closely mimic the lymphoid tumors. As a clinical differential point the amount of external involvement, especially in superficial areas other than the neck, seems of value in the present series.

2. A clinicopathological analysis of 35 cases of so-called lymphosarcoma of the neck reveals a group difference in the total duration of disease life, the general condition of the patient, the response of the tumor to radiation, the amount of external involvement, and perhaps the age of the patient. But in each group the mortality was eventually 100 per cent.

3. Histologically one may prognosticate the total duration of illness from the cell types. Clinically one may evaluate the length of life from the age of the patient, the amount of external involvement, and the general condition of the individual.

4. Histological and clinical data may be correlated. The rate of the disease progression depends upon these factors rather than upon the type or amount of radiation treatment. In fact the better the initial response of the tumor the shorter the duration of life.

5. The histological structure of the lymphogranulomata is more complex and harder to elucidate than that of the lymphosarcomata.

6. Biopsy taking early in the disease as compared with that at a later date is not believed to shorten the patient's life.

7. On account of the present chaos it is suggested that the Lymphoid Tumor Registry, Army Medical Museum, Washington, D. C., be given generous support.

The author wishes to thank the authorities of the Memorial Hospital for permission to study and utilize the data upon which this article is based.

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THE EFFECT OF TREATMENT IN CASES OF CARCINOMA

A STUDY OF ALTERATION OF MALIGNANCY IN METASTATIC GROWTHS AFTER REMOVAL OR IRRADIATION OF PRIMARY GROWTHS[1]

RALPH G. MILLS, M.D., FOND DU LAC, WISCONSIN
ALBERT C. BRODERS, M.D., ROCHESTER, MINNESOTA
The Mayo Clinic
AND
HAROLD D. CAYLOR, M.D., BLUFFTON, INDIANA

THE chief application of the system of grading cases of carcinoma has been to determine the degree of malignancy and to estimate the contingent prognosis for curability and life expectancy. The discussion it has provoked has had the desired effect of focusing attention on the possible significance of cellular differentiation and of causing means for its determination to be developed. In certain instances, even within the period of this study, the criteria have been altered to some degree, and emphasis has come to be placed on characteristics not before sufficiently appreciated. This is all in the line of progress, and further elaboration and wider application are to be welcomed.

It occurred to us to apply this method in the analysis of some of the factors involved in surgical procedures. It was thought that possibly we had found a method by which to evaluate the effect that these procedures seem to have on malignant growths.

The data on which this study is based were derived from the protocols in the Section on Pathologic Anatomy of The Mayo Clinic, and the slides on file there. The period covered included the years 1926 to 1928, inclusive. Only cases were considered in which metastasis was found, and sections to illustrate them were obtained. A slide from the primary tumor, taken either at necropsy, from an operative specimen or from a specimen obtained for biopsy, was essential as a basis of comparison with the various metastatic growths.

For convenience the cases were classified into twelve groups according to the organs in which the primary tumors appeared (Table I), and covered a total of 225 cases. These were exemplified by 1,625 slides, permitting examination of 49 specimens from the primary tumor obtained for biopsy, of 222 specimens from primary tumors obtained at operation or necropsy, and of 661 specimens from metastatic growths obtained either at operation or necropsy, a total of 932 situations. This gives an average of a little less than two slides for each situation.

METHOD OF STUDY

The slides representing a given situation were clipped to a card which bore the necropsy number, for identification purposes, and on which was indicated the site of the primary tumor and the origin of the material shown in the slides. The cards were submitted for grading, one situation at a time, to one of us (Broders) with whom, for a time, was another (Caylor) as collaborator. Opportunity was not afforded at any time for comparison of one situation with another from the same case. Diagnosis and grading were, therefore, conducted on a purely objective basis. The number of cases was so great and the chance of remembering a given case so slight that we

[1]Work done in the Sections on Pathologic Anatomy and Surgical Pathology, The Mayo Clinic, Rochester, Minnesota.

TABLE I.—SUMMARY OF THE ENTIRE SERIES AND OF THE RESULTS OF GRADING THROUGH THE SECOND SURVEY

Situations of primary tumors	Cases	Slides studied	Grades uniform on first examination, cases					Grades uniform on second examination, cases				
			Grade 1	Grade 2	Grade 3	Grade 4	Total	Grade 1	Grade 2	Grade 3	Grade 4	Total
Rectum	26	128		3	3	1	7	2	4	5	4	15
Colon	43	221		6	6	5	17		9	4	2	15
Stomach	49	320			3	22	25		2	4	9	15
Œsophagus	8	47		1		4	5			1		1
Lung	12	155				5	5		1	1	2	4
Breast	8	88				3	3				4	4
Uterus	11	90		1	1	6	8			3		3
Bladder	10	87			1	5	6		2		1	3
Prostate gland	8	62			1		1			1	2	3
Gall bladder	13	101		1	4	1	6			2	1	3
Pancreas	14	130		1		4	5		2	2	1	5
Miscellaneous	23	196	1	1		3	5		3	2	6	11
Totals	225	1625	1	14	19	59	93	2	23	25	32	82

confidently assert that the examination represented an unbiased diagnosis based on the sections presented. In some instances, the small amount of tumor present, the effect of secondary changes in the tissues, and the state of preservation, made the grading very difficult. However, in the tabulation of the results, no allowance has been made for these difficulties.

While this study was being made a slight change took place in the criteria by which to grade adenocarcinoma. The chief point to note in this connection is the stress that is now placed on the characteristics of the cells, and the little, if any, stress that is placed on the mucoid material which many of the cells elaborate. This is the reason for many of the changes in grading which, as will be seen, were made when re-examination of some of the slides was made.

In Table I may be seen the number of cases found in each of the twelve groups and the slides available in each. Those in which all slides from the different situations of a given case were diagnosed as being of the same grade totaled 93.

After all slides from the different situations had been graded, those cases in which discrepancies occurred were again submitted for study, but this time all slides from the same case were submitted together.

Uniformity of grading of specimens from the different situations was not obtained on the first examination in 132 cases. Those cases which were brought into uniformity by changes in the grade on the second examination are analyzed in Table I. In a total of 82 cases, the gradings of 124 slides were thus changed, an average of about one and a half alterations for each case. It will be noticed that a large proportion of the tumors which were recognized consistently at the first examination were graded 4. Many more, proportionately, of those which ultimately were graded 2 and 3 required alteration. Many of the slides thus altered had been graded "high 2 or low 3," indicating that they were close to the borderline between two grades.

A total of 151 slides (from 132 cases) were altered in grade. As has been pointed out, 124 of these slides concerned the cases in which grading was thus made uniform. In a total of 50 cases grading still was not uniform after second survey, although in 27 slides in this group it was possible to make changes in grade. It should be added, also, that some of these changes increased rather than decreased the differences between the grades assigned.

TABLE II.—SUMMARY OF CHANGES IN GRADE MADE IN 151 SLIDES FROM 132 CASES, INCLUDING THE 50 CASES IN WHICH GRADING STILL WAS NOT UNIFORM AFTER THE SECOND SURVEY.

Situations of primary tumors	Slides								Cases with persisting variations in grade
	Grade 1 to 2	Grade 2 to 1	Grade 2 to 3	Grade 2 to 4	Grade 3 to 2	Grade 3 to 4	Grade 4 to 3	Total	
Rectum	1	2	7		5	5	2	22	4
Colon	1		4		9	7	5	26	11
Stomach	2		3	2	3	13	3	26	9
Œsophagus			2				1	3	2
Lung			1		4	4		9	3
Breast						6	2	8	1
Uterus			3				2	5	
Bladder			1		5	2		8	1
Prostate gland			1			3		4	4
Gall bladder		1	6			2	1	10	4
Pancreas	1		2		3	2	2	10	4
Miscellaneous			2		8	7	3	20	7
Totals	5	3	32	2	37	51	21	151	50

The nature of these changes, including those in the group of 50, is indicated in Table II. An alteration from a lower to a higher grade was made in 90 instances, and from a higher to a lower grade in 61. This difference in the figures suggests that, for one reason or another, the slides tended to indicate a lower, rather than a higher, grade of malignancy.

There were cases of carcinoma in every organ except one of those listed, in which grading was not reduced to uniformity by the second survey. This exceptional group of carcinomata involved the uterus, which will be considered later.

In the second survey it was deemed necessary to alter the grading of specimens obtained for biopsy as well as of specimens of primary tumors obtained at operation or necropsy, in view of the study of each entire case. The number of changes of this sort is shown in Table III. The ratio of approximately one change in grade in seven diagnoses was maintained throughout the examinations of slides of specimens obtained from primary tumors

TABLE III.—CHANGES IN GRADE MADE IN THE SECOND SURVEY

Situations of primary tumors	Specimens obtained for biopsy		Specimens of primary tumors obtained at operation or necropsy		Specimens of metastatic growths obtained at operation or necropsy	
	Total	Altered	Total	Altered	Total	Altered
Rectum	4	1	26	9	47	12
Colon	5		43	5	88	26
Stomach	6	1	49	7	128	18
Œsophagus	1		8	1	22	2
Lung	3	2	12	1	64	6
Breast			7	1	45	7
Uterus	10		10		35	5
Bladder	8		10	2	38	6
Prostategland	2	1	8		17	3
Gall bladder	4		13	1	45	9
Pancreas			14	3	56	7
Miscellaneous	6	2	22	5	76	13
Totals	49	7	222	35	661	109

for biopsy, from primary tumors at operation or necropsy, or from metastatic growths at operation or necropsy.

In Table II, it may be noted that almost all the changes involve a shift from one grade to an adjacent one. There are two exceptions to this statement, and both are found in the series of gastric carcinomata. The reason for the shift of two grades instead of one, as in all other instances, was sought by a special study of the cases in question. In one instance the matter hinged on the significance to be attached to the presence of mucoid material. In the other, the few tumor cells had been crowded into a group of lymphatic vessels which gave to the cellular masses a false acinar appearance.

The group of 50 cases in which uniformity of grade was not secured by the two examinations is probably the most significant in the series. It is conceivable that treatment may have exerted an influence in disturbing the uniformity of growth in the metastatic tumors. If irradiation, or removal of the primary growth, can retard the growth of carcinomatous cells or can remove a stimulus by which their growth is accelerated, then full recognition of these facts should be given.

The only criterion of such retardation or acceleration that can be evaluated in this study is that which is manifest by alteration in histological structure. Failure to detect such changes, as indicated by morphological response, suggests that prolongation of life may be attributable to changes in the animal body rather than in the parasitic carcinomatous cells. To this end, a study was made to estimate the influence exerted by irradiation and by removal of the primary growth to the extent that the data justify.

Some form of irradiation was used in 33 cases of this series; roentgen-rays only were used in 16 cases, radium only in 7, and both roentgen-rays and radium in 10. Details of treatment by irradiation were supplied by Desjardins and Bowing. In the smaller series of 50 cases in which persistent variations in the grade of the tumors was displayed, irradiation had been applied in only two; they were both cases of adenocarcinoma of the kidney, and roentgen-rays only had been applied. The number of cases in this series of 50 in which treatment was given seems to be disproportionately low (4 per cent) as compared with 14 per cent of the entire series. If irradiation inhibits the growth of metastasis of tumors, it apparently does not do so by altering the virulence of the cells to the extent of lowering the grade of malignancy. But in the two cases just mentioned the virulence of the cells did seem to be altered. The primary tumors were graded 2. One metastasized and was graded 3, and metastasis from the other was graded 4 in all situations except one, in which it was graded 2.

As has been recorded, instances in which variation in grade persisted after re-examination were found in tumors of all the twelve groups of organs in which the primary growths occurred, except those of the uterus. Of the whole series of 225, 11 patients had tumors of the uterus. Nine of these had received some form of irradiation; some of them had been repeatedly treated. In one case the carcinoma, which had arisen in the cervix, had been completely destroyed by this means. However, in the course of the treatment, the grade had been determined three times by biopsy of tissue from different but adjacent tissues. At necropsy, performed 15 months after treatment was instituted, carcinoma was found in 5 situations. In this case all growths except one were graded 3 at the first examination, and this grading was changed from 2 to 3 on restudy.

No alteration in the grade of any specimen obtained for biopsy or of any primary tumor of the uterus was made, and only five changes in 3 cases were made in all the metastatic growths. The result was that eventually the 11 cases presented complete uniformity in the grade of the specimens obtained for biopsy, of the primary tumors obtained at operation or necropsy, and of the metastatic growths obtained at operation or necropsy.

Variations in the degree of cellular differentiation, implying lack of uniformity in the growth of the tumor, have been noted. These have been attributed to inhibitory effects of irradiation on the tumor cells, and have been so observed in series, for the most part derived successively from specimens of the same origin obtained for biopsy and at operation. They have not been adequately controlled by observations on the behavior of tumors in other situations than the uterus. Nor have they been compared with the metastatic growths of such tumors in other situations.

In the present series of tumors of the uterus, the variation within a single slide has been surprisingly slight, and to this fact is due the uniformity in grade at the time of the first examination. In specimens of some of the other organs the variation in grade in a single slide ranged from 1 to 4. A small region sometimes contained masses of cells that, if considered alone, would warrant a diagnosis of malignancy graded 1, and near by, another portion sometimes would be graded 4; various intermediate stages also were found. This variation was noted repeatedly, and many of the alterations were made in those slides in which an attempt had been made to strike a general average, and to compromise on grade 3 or grade 2.

The evidence, then, so far as it goes, shows that irradiation can completely eradicate a primary growth when, like tumor of the cervix, it can be reached by these means. How many patients can be cured by irradiation

TABLE IV.—COMPARISON OF PRIMARY TUMORS AND OF CORRESPONDING METASTATIC GROWTHS IN 32 CASES WITH PERSISTENT VARIATION IN GRADE

	Primary tumors, grade	Growths in lymph nodes, grade	Metastatic growths outside of lymph nodes, grade
Rectum	4	Regional, 3; pancreatic, 4	Lungs, 3
	4	Regional, 2	Liver, 3; peritoneum, 3; ileum, 3; bladder, 4
	3	Regional, 3	Liver, 2; peritoneum, 3
	2	Regional, 3	
Colon	2		Liver, 3; pancreas, 3
	4		Liver, 2
	1		Liver, 2
	2		Colon (recurrence?), 3
	4		Lungs (low), 3; liver, 4
	2	Regional, 1	
	2	Hilum, 1	Lungs, 2; ileum, 2
	3	Regional, 2	Liver, 3
Stomach	4	Regional, 3	
	3	Regional, 4	Liver, 4; pancreas, 3; colon, 3
	3		
	3	Regional, 4	
Œsophagus	4	Regional, 4	Pancreas, 3; spleen, 4
	3	Regional, 3; abdominal, 3	Lungs, 3; liver, 4; heart (left ventricle), 4
Lung	4	Regional, 4	Lungs, 3; liver, 4; brain, 4; suprarenal glands, 4; kidney, 4
Breast	3	Regional, 3	Lungs, 3; liver, 4; pituitary, 3; thorax, 3; skin, 3; pleura, 3; other breast, 2
Bladder	4	Regional, 4	Lungs, 3; liver, 4; stomach (primary?), 4; spleen, 4; skin, 4; suprarenal gland, 4; thyroid gland 4; kidney, 4; pancreas, 4; gall bladder, 4
Prostate gland	3		Lungs, 4
	2	Regional, 3	Lungs, 2; prostate gland (recurrence), 3
	2	Regional, 4	
Gall bladder	2	Regional, 2	Lungs, 2; liver, 2; common bile duct, 3
Pancreas	4	Regional, 4	Lungs, 2; liver, 4
	4		Lungs, 1; liver, 3; portal vein, 3
	3	Regional, 4	Liver, 3; duodenal ulcer, 3; cystic duct, 1 and 3; suprarenal gland, 2 (1-3)
Miscellaneous	4	Regional, 4	Lungs, 3; liver (ileum or liver, primary), 3
	2		Lungs, 4; (hypernephroma)
	2	Regional, 4; mediastinal, 4	Lungs, 4; brain, 4; flank (hypernephroma), 2
	2		Lungs, 3; mediastinum, 3; veins of neck, 3

must be demonstrated by studies radically different from this. The unusual uniformity in grade of tumors of the uterus suggests that cells which remain viable in spite of irradiation may not be altered in their histological appearance. Local variations in cellular differentiation may indicate a type of inherent unrest but do not prove that irradiation can modify the type of growth that takes place in metastasis. Histologically the cells maintain to an unusual degree the characteristics manifested in the primary growth.

In 57 cases the primary tumor was removed, and in 11 of these persistent variation from the grade of the primary tumor was found in the grading of the metastatic growths. Most of the primary growths in these 11 cases occurred in the groups of organs designated as the rectum, colon, stomach, breast, and miscellaneous viscera. Only 5 of the 11 patients lived more than 1 month; the series, therefore, is too small to warrant further study. It was noted, however, that there was a tendency for the metastatic growth to carry a higher grade of malignancy than the primary tumor in most of the 5 cases in which the patients lived for the longer periods. The 6 remaining patients lived such a short time after operation that removal of the tumor could have had no appreciable influence on the metastatic growths.

When there is lack of uniformity in the grading of a primary tumor and of the metastatic growth or growths that originate from it the first question raised is that of the existence of multiple primary malignant growths. The series of 50 cases in which uniformity of grade was not secured by re-examination,

therefore, was restudied with this point in mind. Exceptionally, one tumor may present such irregularities or variations in its growth as to justify one grade in one situation and another grade in another situation. Presumably, however, there would be a general similarity in the growth in all situations; the chief, or perhaps the only, difference observed would be in the extent of the differentiation of individual cells. Usually, metastatic growths from a single source would not be composed of glandular cells in one portion and of squamous cells in another. Yet it is known that this does occur, and it did occur in several instances in metastatic carcinomata derived from growths of the gall bladder and the bronchi. However, they were considered in the present study as having been derived from the same source.

In several instances, a primary adenoma, in which carcinomatous change had occurred, was found in the intestine, and this had given rise to perhaps one metastatic growth. However, there was a larger primary tumor elsewhere. Such a case was discarded because of the confusion which it was likely to cause.

In a few cases, a metastatic growth was encountered that differed materially from the known primary tumor and had suggestive resemblance to carcinoma arising in such an organ as the thyroid gland. The protocol might indicate that the thyroid gland had been examined, but to rule out the possibility that the metastatic growth was derived from a carcinoma of the thyroid gland is at present impossible. Although a special system was in operation to reduce the possibility of mixing and misplacing slides, nevertheless this possibility must be taken into consideration and due allowance made for it.

The question arose several times as to the presence of two tumors of the same kind and similar grade. To analyze these fully would carry one too far afield. Multiple tumors of different grades were studied only to determine that two tumors really existed, rather than to seek an explanation for difference in grade on the basis of variation in the growth of one.

It is perhaps unnecessary to state that cases in which diagnosis of multiple tumors had been made at necropsy were excluded from this study. It was the assumption in all cases retained in the series that a single primary tumor had given rise to the metastatic growth that was encountered. For one or more of these reasons, 18 cases were discarded from the 50 in which variation in grade persisted on re-examination, leaving in the series a total of 32 cases in which grading could not be made uniform (Table IV).

The variations in grading within a given case gives one certain distinct impressions. In 11 of the 32 cases (Table IV) metastasis in regional lymph nodes was not discovered. Of the remaining 21 cases, the grades of primary tumors, as compared with the grades of metastatic tumors in the regional nodes, were the same in 9 cases, and were more or less malignant in about equal proportions of the remaining 12. A step upward of one grade was noted in 5 cases and of two grades in 2 cases. There was also a step downward of one grade in 4 cases and of two grades in 1 case. Metastasis in other than the regional nodes was not so common as to warrant conclusions.

Metastasis was found in the lungs in 16 of the 32 cases. The grading as compared with the primary tumor was the same in 5 cases; it was raised one grade in 2 cases, and two grades in 2 cases. It was decreased one grade in 5 cases, two grades in 1 case, and three grades in 1 case. There seemed to be a tendency for some carcinomata to become a little less malignant when they became implanted in the lungs.

Metastasis to the liver was found in 17 cases. In 7, the grading was the same in the liver as in the primary growth. In 4 cases it was one grade lower, and in 1 case two grades; it was elevated one grade in 5 cases. There seemed, then, to be about the same number of cases in which an increase in evidence of malignancy took place as there were cases of evidence of decrease in malignancy.

The number of situations in which these 32 tumors were studied varied from two to eight. The number of situations in which the grade of malignancy of the metastatic growth varied from that of the primary growth was in 21 cases confined to a single slide. Of slides in which the grade of malignancy was at variance with that of the primary growth, in 6

cases there were two slides, in 3 cases there were three, and in 2 cases there were four.

The situations, other than those mentioned, in which metastasis took place, were scattered and varied, and no one of them was represented by a sufficient number of cases to permit even an impression of the influence which they might have exerted on tumor cells developing in them. However, for the sake of subsequent work of a similar nature which should be done on a much larger series the results of this study are placed on record.

A certain degree of variation was encountered in the different sections taken from the primary growth. To consider this feature would take us too far afield, but it may be assumed that cells in such a growth which had differentiated least, or those that were the most malignant, would be the most likely to metastasize first and to the widest extent. A chance slide of the primary growth, taken through a region of greater differentiation, would lead to a diagnosis of a lower grade of malignancy than would be found in the metastatic growth. This would then represent an unavoidable error, and one that must be taken into account in this study.

This variation in the degree of differentiation of cells in a given region also was encountered frequently in metastatic growths. It is hardly likely that the cells of a highly malignant portion had been directly derived from a similar area in the primary growth, whereas those with more differentiation had sprung from a region of more differentiation in the primary growth, and that the two sets of cells had metastasized together. Rather, one is inclined to believe that the cells in a given metastatic growth were derived from the same cell or small group of cells that was responsible for the metastatic tumor. If this is true, it is evident that there is an inherent tendency of the carcinoma cells to assume a varying degree of differentiation under identical circumstances, comparable, perhaps, to the different course followed by the members of one family when they remain indefinitely in the same household. The variation in the cellular characteristics and in the degree of differentiation seems to be at least partly an inherent quality, not subject to any form of critical analysis of which we have knowledge. It was hoped, by this study, to analyze, by a method not before used, organic environment of these carcinomatous cells in the light of certain variable factors to such as favorability of tissue environment, removal of a possible stimulus from the continued presence of the primary growth, and the deleterious effect of irradiation on the masses of cells. The effect seems to have been to remove still farther into the distance the prospects of determining just the ecological factors concerned in growth of cells and metastatic tumors under the conditions of malignancy. It is felt, however, that a beginning has been made in a method of analysis which might yield more definite results in a series much larger than it has been possible to study at the present time.

SUMMARY

The system of grading of carcinoma, devised by Broders, has been applied to the study of a series of fatal cases of carcinoma, to detect, if possible, the potency of various factors that may affect metastatic growths and even the viability of carcinomatous masses.

Alterations in the histological structure of malignant metastatic growths might be expected to be found, if longevity after operation or treatment by irradiation is dependent on changes in the cell.

Evidence was not found that removal of the primary growth or irradiation altered, to an appreciable degree, the histological structure of metastatic malignant growths.

Irreconcilable variation between the grade of the primary malignant tumor and that of the metastatic growths, between different portions of the same primary growth, or between different metastatic growths of the same subject occurred in 32 of 207 cases (the entire series of cases was 225 in 50 of which variation persisted after the second survey and 18 of the 50 were finally excluded from the series because the question of multiple primary tumor entered in). The cause of this variation seemed to be inherent in the carcinoma rather than connected with the ecological factors that surrounded it. Growth of metastatic masses in the lung seemed to be slightly inhibited

merely by ecological factors in the lung, but there was no noticeable influence exerted by any other organ on metastatic growths which developed within it.

A method of approach has been developed which should be applied to a much larger series of cases, in order properly to analyze the factors involved.

SQUAMOUS CELL CARCINOMA OF THE GALL BLADDER

JACOB RABINOVITCH, B.Sc., M.D., C.M., AND ROLAND S. KIEFFER, M.D., ST. LOUIS, MISSOURI
From the Department of Pathology and Surgery of the Missouri Baptist Hospital, St. Louis

THE various factors concerned in cell metaplasia are still obscure although many theories have been advanced to explain this apparent histological change from one cell type into another. Thus, according to Lubarsch and Schriddle, anaplasia, or retrogression to a more primitive type of cell, is the essential forerunner of cell metaplasia, while Herxheimer attributed the change to embryonic rests which later in life assume growth characteristics of the embryonic type of cell. While these theories were found to hold true in a certain group of cases, they failed to explain on the other hand a great variety of other cases in which metaplasia played an essential rôle. Krompecher has recently advanced a rather plausible theory explaining the process of metaplasia from quite a different point of view. This theory is based on personal careful observations in a very large series of cases and is essentially as follows: He found in the mucosa of certain organs, viz., stomach, appendix, colon, and uterus, which normally are lined by cylindrical epithelium, another—a basal layer of cells. The latter are found unevenly distributed, are round or oval in shape, and poor in protoplasm; their nuclei are rich in chromatin. He considered these basement cells analogous to the basal cell layer of the skin and that they give rise to the glandular and cylindrical epithelium. Under certain pathologic conditions these so called basal cells are able to form either flat epithelium, cylindrical epithelium, or both. Cell metaplasia according to Krompecher is therefore not a result of a post embryonic change in the histological appearance of the cell, but is due to differentiation of the basal cells into either squamous or cylindrical epithelium as the case may be. Teutschlander supports this theory and finds it to hold true in explaining certain metaplastic changes that sometimes occur in the respiratory tract.

We are primarily concerned in this paper with metaplasia that occurs in the gall bladder. The normal mucosal lining of this organ is one layer of tall columnar epithelium. The finding, therefore, of a squamous cell carcinoma in the gall bladder is unusual, and we believed that it would be of interest to report the following case and discuss the various phases of metaplasia as they stand in relation to the gall bladder.

M.S., a white female, aged 44 years, entered the Missouri Baptist Hospital on July 21, 1930, complaining of pain in the right upper quadrant of the abdomen. The onset of the present illness she dates back to July 3, 1930, when she was seized with an attack of pain, dull in character and confined to the right upper quadrant. This pain was accompanied by nausea, vomiting, and jaundice. While rubbing her abdomen in order to soothe the pain she felt a mass in the right hypochondriac region; she was entirely unaware of the existence of this mass until then. The patient, however, had had similar attacks of pain and jaundice at intermittent periods of 5 to 6 months for the past 7 years. She was always in good health excepting for repair of the pelvic floor performed 7 years ago. She gets short of breath on exertion and the ankles swell at night. She has four children who are living and well. She also had one miscarriage. The menses are normal.

Physical examination. The physical findings on admission to the hospital were briefly as follows: A poorly developed and slightly anæmic white female with a questionable jaundice of the skin. Most of the teeth were absent and those remaining were dirty and carious. The heart and lungs were normal; blood pressure was 120–78. The abdomen was slightly pendulous, soft, and free from tenderness or

spasticity. A large mass corresponding in size to that of a fist was felt in the right upper quadrant; this mass was irregular and pear shaped in outline. It appeared to move with respiration, was not tender, and seemed to arise from the gall bladder.

Laboratory findings. The urine was essentially negative; the red blood cells numbered 4,000,000, the white blood cell 8,000, and hæmoglobin 50 per cent.

Operation was performed on July 23, 1930. A right rectus incision was made to explore the gall bladder. The latter was found very much enlarged and contained a tumor mass which extended downward and embraced the transverse colon at the hepatic flexure. The gall bladder was detached from the liver and from its attachment to the colon with a moderate degree of ease. The abdominal wall was then closed in layers.

Pathological examination of the gall bladder (Fig. 1) revealed a very much enlarged organ measuring 11 centimeters in length. The serous surface was ragged and the wall considerably thickened. The greatest degree of thickness was noted in the fundus. When the gall bladder was opened the cavity was found to contain numerous stones of various sizes. The mucous surface presented a purplish discoloration excepting at the region of the fundus where it was more of a grayish white color and grossly appeared like carcinoma. Areas of necrosis and softening were found in the latter situation.

Microscopic sections taken from the inflamed areas of the gall bladder distant to the tumor revealed various changes. The surface epithelium was for the greater part denuded and where still intact it was either one or several cell layers deep. The wall was considerably thickened because of œdema and abundant connective tissue formation. The latter was densely infiltrated with leucocytes and lymphocytes.

Sections taken from the wall of the gall bladder closer to the tumor showed, in addition to the inflammatory reaction described, infiltration of the detached surface epithelium into the deeper layers of the wall. The former were arranged in duct-like structures and were found to invaginate the entire thickness of the wall reaching as far as the serosa. These structures are known as the Aschoff-Rokitansky sinuses and are not uncommonly found in gall bladders that have been the seat of chronic inflammation. Some of the sinuses found in this gall bladder were lined by only one layer of cylindrical epithelium while others were several cell layers deep. In the latter case the morphological character of the epithelium was changed from the normal and in places exhibited numerous mitotic cell divisions. In these sinuses there was evidence of the first change from the normal to the abnormal epithelium, while at a point still closer to the tumor the sinuses appeared as definitely malignant and resembled a duct carcinoma. Another interesting feature noted here was a sudden change in the histological appearance of some of the epithelium lining the sinuses, namely a transformation of the cylindrical epithelium into a squamous cell carcinoma. The microscopic picture was therefore that of a combined cylindrical and squamous cell carcinoma (Fig. 2). Sections obtained from the main tumor mass revealed entirely a squamous cell carcinoma with characteristic pearl formation. In these latter areas the tumor has lost entirely its cylindrical cell character and had been transformed into a purely squamous cell malignant neoplasm (Fig. 3).

We find therefore in this gall bladder several interesting changes resulting probably from a common etiological cause. In the first place, there is the presence of inflammation and stone formation apparently of long duration, judging from the increased thickness and pathological changes of the wall in addition to the well formed stones. Second, there is the presence of a combined cylindrical and squamous cell carcinoma, the latter being completely differentiated in the main tumor mass.

The various histopathological findings noted in this gall bladder are rather interesting and shed valuable light on the relationship existing between chronic inflammation, stone formation, and carcinoma, as well as on the problem of the histogenesis of squamous cell carcinoma of the gall bladder and epithelial metaplasia. Since the true etiology of the disease is not determined one is reduced to speculations regarding the mode of dependence of the tumor process upon the irritant. It is almost an undisputed fact, however, that irritation resulting either from chronic inflammation, stones, or both, plays a very important rôle in the development of carcinoma of the gall bladder. According to Rolleston, at least 4 to 14 per cent of all people suffering from cholelithiasis develop carcinoma of the gall bladder. In numerous microscopic sections taken from inflamed gall bladders either with or without stones, we have found evidence of active proliferation of the mucosal epithelium. In addition, some of this epithelium has detached itself in places from the surface and has become buried in the deeper strata of the wall, reaching at times as far as the serosa. They usually have the appearance of duct-like structures or sinuses and the epithelium is often several layers thick. Among these cells mitotic figures are often found, indicating rapid growth. It is quite probable that such epithelial strands in the depth of the wall are the forerunners of new growths, and evidence to that effect has been noted in the gall bladder of our patient (Fig. 4). While irritation,

Fig. 1. Appearance of gall bladder removed at operation. Note the thickened wall particularly in the region of the fundus where a carcinomatous change has taken place in the wall. The cavity is seen to contain several stones and the mucosa is discolored.

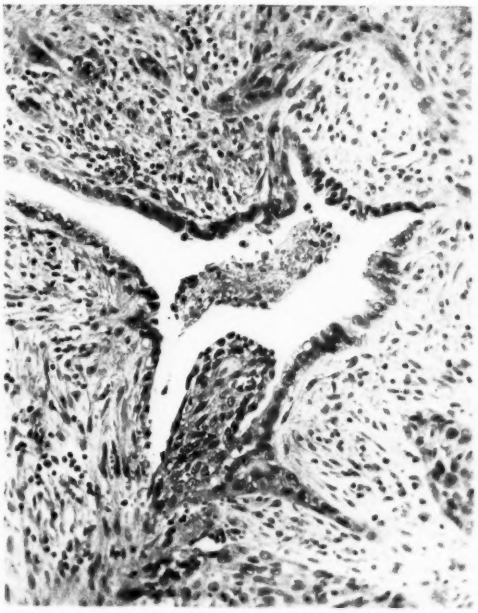

Fig. 2. Mixed cylindrical and squamous cell carcinoma in the wall of the gall bladder. Note the transformation of the cylindrical epithelium lining one of the sinuses into a squamous cell carcinoma.

therefore, resulting from chronic inflammation and stone formation offers only indirect proof as to its relation to tumor formation, yet the frequency with which the two occur prompts us to accept it as an important etiological factor.

Of greater importance and interest to us is the development of a squamous cell carcinoma in an organ in which the mucosa is normally lined with columnar epithelium, and in which flat epithelium is at no time present. Although such cases are not very infrequent, their finding attracts great interest. In a recent publication by Roessiger on squamous and mixed cell type carcinoma of the gall bladder, the author ascribes the origin of the squamous cells to the basal cell layer noted in the gall bladder mucosa. Roessiger bases his arguments as to the development of a squamous cell carcinoma in this organ on Krompecher's theory, namely, that the basal cell is multipotent and is therefore capable of developing into either cylindrical or flat epithelium. He found in 21 inflamed gall bladders associated with cholelithiasis, this so called basal cell layer described by Krompecher. He also found similar cells in the normal gall bladder. Roessiger concludes, therefore, that the squamous cell carcinoma that is occasionally encountered in the gall bladder is a direct derivative of the basal cell layer found in the mucosal lining of this organ.

In a series of normal gall bladders which we have studied we were unable to find such basal cells. However, in pathological specimens, particularly of long standing inflammation and cholelithiasis, we have found a deeper layer of cells in the mucosa which in all probability corresponds to the basal cells described by Roessiger and Krompecher. In this deeper layer of cells mitotic figures were often observed; these cells are probably concerned with cell proliferation and regeneration. At no place, however, was there any direct evidence of transition from cylindrical to squamous epithelium, although such a change might nevertheless occur.

The histopathological findings presented in our case show two distinct morphological

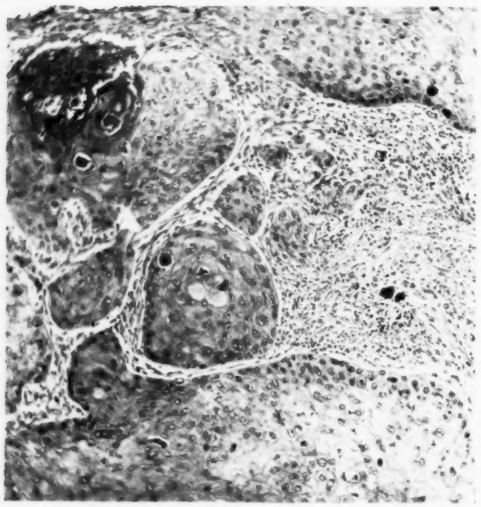

Fig. 3. Squamous cell carcinoma of the gall bladder. Note the character of the epithelium and the typical pearl formation.

Fig. 4. Aschoff-Rokitansky sinuses in the deeper layers of the wall of the gall bladder. This section was taken from another case of cholecystitis and cholelithiasis and it serves to demonstrate how the sinuses once detached from the surface infiltrate into the deeper structures of the wall and in places undergo considerable cell proliferation. Mitotic figures are often found in these cells.

changes, first, a rather sudden transition from a microscopically normal epithelium to one of a distinctly malignant form and second, a structural independence between cylindrical and squamous cell carcinoma. This finding would lead one to assume that the epithelial growths have in all probabilities a common genetic origin and that they are both capable of responding to the same growth stimulant. If we were to conceive then the process of tumor metaplasia in this light, we could state definitely that the different configurations noted in a mixed cylindrical and squamous cell carcinoma as exemplified in our case, are not separate and distinct tumor entities but different morphological phases of growth of one and the same tumor type. In other words, we are probably dealing in such instances with a tumor arising from a common type of cell which under the influence of the irritant has acquired two different histological cell characteristics, namely, that of cylindrical and squamous epithelium. Furthermore, since the greatest degree of cell proliferation is seen in the deeper basal cell layers, we are also inclined to believe that the latter are responsible for either type of tumor formation. According to this assumption, the development of two histologically different kinds of neoplasm in the same organ is rendered possible through differentiation of the basal cells into cylindrical and squamous epithelium.

Another interesting question that arises from a case as we have described, is the manner in which a squamous cell carcinoma develops from a cylindrical cell epithelium. One wonders whether the cylindrical cells are first transformed into normal squamous cells and then in turn converted into carcinoma, or is the process a direct transformation of the basal cells into a heterologous type of carcinoma. We are as yet unprepared to answer this question definitely, but, from careful microscopic examination of various sections which we have made, it seems to us that this

transition is a direct one. At no place could we find in the gall bladder any evidence of normal squamous epithelium, and we are therefore inclined to believe that this is a direct transformation of the original cylindrical epithelium into that of a final squamous cell neoplasm.

SUMMARY

A case is presented in which a squamous cell carcinoma of the gall bladder was found; in addition to the tumor in the gall bladder, there was also found evidence of chronic inflammation and stone formation in that organ.

The various phases of cell metaplasia are discussed particularly with reference to the gall bladder.

NOTE.—We wish to express our thanks to Dr. H. A. McCordock of the Department of Pathology of Washington University for making our photomicrographs. We are also indebted to Dr. A. O. Ambrose for referring the patient to our service.

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FIBROUS PERITONITIS OF NECK OF HERNIAL SAC[1]

V. L. SCHRAGER, M.D., AND J. T. GAULT, M.D., CHICAGO

FIBROSIS within the hernial sac is quite a common occurrence. We are concerned, however, only with the circumscribed ring-like fibrosis occurring at the neck of the sac, which has a definite anatomical and pathological significance.

For many years one of us, (V. L. S.), observed in a fair percentage of cases a definite ring fibrosis at the neck of the sac in indirect inguinal hernias. The ring was always flush with the internal ring, it was very tough, and it was striking in that the rest of the surface of the sac was perfectly smooth and appeared grossly quite normal. It was never found in direct hernia. *A priori*, Schrager was forced to conclude that the ring could hardly be of pyogenic inflammatory origin, since the remainder of the peritoneal surface showed no gross evidence of inflammatory changes. It was further observed that the most severe types of strangulation were those in which the viscus was caught in a tight fibrous ring, making the release laborious and the pathology severe. Replacement of the bowel was always difficult and occasionally impossible, lest the fibrous ring itself be divided before further useless manipulation. A definite circular necrosis was always present in strangulations within a fibrous ring.

The existence, frequency, and damaging influence of this narrow, circular fibrosis at the neck of the sac, obvious to us in many cases, is either seldom or never mentioned in the literature of hernia. At all events, the ring was never exalted to the importance it justly deserves.

Diffuse, inflammatory changes within hernial sacs, however, are pretty well known and recorded.

Peritonitis of hernial sacs, according to Piquet, is more common in umbilical than in inguinal hernias. The inflammatory process may be a part of inflammatory changes within the peritoneal sac, or be limited to the hernial sac only, cases of the latter type being reported by Lemoniet and Theilhaber. B. Schmidt states that localized inflammation in an empty hernial sac is rare, on the other hand Sutter in 1907 reported 30 such cases. Similar cases were reported by Dubs.

The etiology of the inflammatory process may be bacterial, mechanical, or may be due to extension from neighboring structures. Bacteria can readily migrate from the peritoneal surface into an open hernial sac, the latter being merely a diverticulum thereof; cases, however, in which the process is limited to the sac cannot easily be explained on bacterial grounds alone. F. Kempf, who found adhesive peritonitis within the sac without palpable mechanical or bacterial cause, nevertheless believes that a bacterial process must have operated sometime. Contact of the peritoneal surface of the sac with the intestine and omentum may cause inflammatory changes. A tight fitting truss, various types of injections for the cure of hernia, repeated muscular contractions at the internal ring, are the principal mechanical factors. Hernial sacs may be invaded by bacteria by way of infective metastases from distant foci, or be infected by contiguity. In the case of Nusbaum, the inflammation extended from an inguinal lymphadenitis, secondary to urethritis, while in the case of Charnois, it was secondary to appendicitis.

Inflammation within the sac betrays itself clinically by pain, although cases of extensive local peritonitis without symptoms have been described by von Essau. B. Schmidt, discussing pathological changes in the sac, considers them the sequence of peritoneal inflammatory changes and classifies them in three groups: serous, fibrinous, and purulent. Occasionally tuberculosis of the hernial sac antedates fibrosis (Schrager).

George H. Smith remarks that hernial sacs rarely have been sectioned. He undertook the task of sectioning 250 hernial sacs, the material coming from various sources. The common finding in his cases was thickened areas of fibrosis beneath the endothelium. Grossly

[1] From the Department of Surgery, Northwestern University Medical School; the Cook County and Mount Sinai Hospitals, Chicago.

they can be seen on the inner surface of the sac, either at the fundus or the neck. In 37 specimens, there was definite evidence of acute inflammation, irrespective of whether the patient wore a truss or not. The youngest patient was 2 years, and the oldest 72 years. Pain was present in many of these cases. There was tuberculosis in one specimen. Smith states that recent hernias show evidence of subacute inflammation of the subendothelial connective tissue, especially if acquired during muscular strain.

The sequence of these inflammatory changes are constrictions and bands of adhesions. Richter, in his classical monograph on hernia, about one hundred years old, recognized and described adhesions in hernial sacs. It is historically interesting to note that Maupas, in 1551, and Ambroise Paré, operated upon and cured hernias simply by dividing fibrous bands within the sac. Jaboulay and Patel describe constrictions within the sac located either at the internal or external ring. In other cases, they observed "multiple constrictions," the result of localized peritonitis. Strangulations of hernial contents by adhesive bands were recognized by Riolan, Littré, Saviard, Méry, and others. W. B. De Garmo, of New York, in his monograph on *Abdominal Hernia* refers to certain changes in structure, frequently found in hernia, "important because they frequently are the immediate cause of strangulated hernia." He speaks of tough fibrous rings capable of severe strangulations.

Seward Erdman, in the chapter on hernia, states "very rarely, the sac itself is the constricting factor." Fusion of two peritoneal layers is more apt to occur at the point of the greatest contact, therefore, at the neck. The sequence of the agglutination may amount to a cure. This is the principle of the cure of hernia by injection of irritating substances. The strangulation, or repeated strangulations, which reduce themselves spontaneously, cause moderate peritoneal changes with subsequent fibrosis and ultimate cure.

Fibrous bands may be limited to the lumen of the hernial sac or extend into the peritoneal cavity; they may partition, sacculate, agglutinate surfaces, or give rise to encapsulated

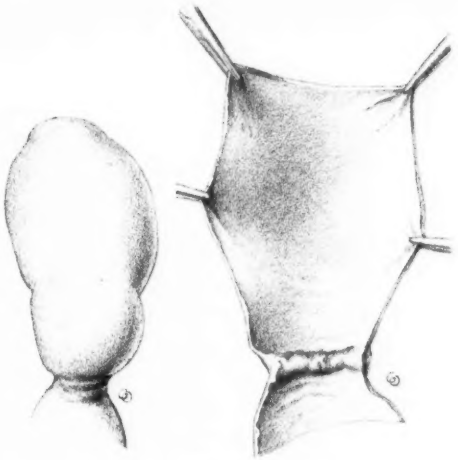

Fig. 1, left. Distended unopened sac with constriction at neck.

Fig. 2. Opened sac, showing fibrous ridge at the neck and normal, smooth peritoneal surface of remainder. (Drawn from actual specimen.)

cysts. Painful hernias are to be suspected as having adhesions, which under physical strain exert a pull upon the peritoneum, notoriously sensitive. Fibrous bands may be found in various portions of the sac; some of them, however, are located "at the narrow points, associated with the obliteration of the processus vaginalis" (Watson). After the descent of the testicle, narrow points occur at the internal ring and "a little later" at a point just above the epididymis (Watson). Clough found a strangulation due to a constriction in the tunica vaginalis near the testis. Moschkowitz reported three similar cases and Watson reported one. George Gray Turner found a scrotal hernia strangulated at a point 6 inches below the external ring.

Riolan, Winslow, Dionis, and the majority of the members of the Academy of Surgery of Paris, considered fibrous rings as a sole cause of strangulation in hernia. Dupuytren, on the other hand, in his classical lectures, as well as through the writings of Marx (1832) considered strangulation by fibrous bands rather the exception than the rule. Astley Cooper and other English surgeons also opposed the theory of strangulation by fibrous bands. Malgaigne, although opposed to the theory of

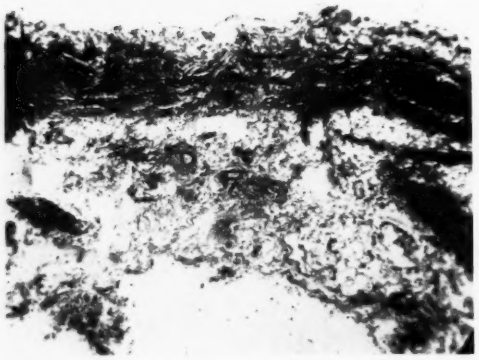

Fig. 3. Section from normal portion of sac. (From specimen shown in illustration 2.)

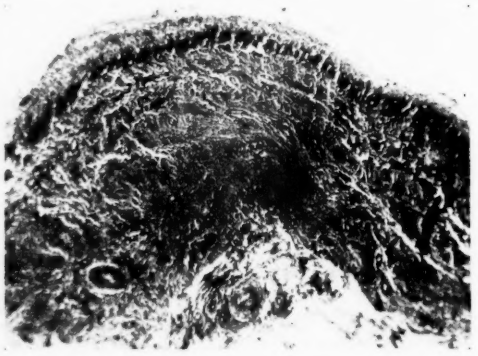

Fig. 4. Section from thickened portion of sac showing greatly increased amount of connective tissue. (From specimen shown in illustration 7.)

constriction by fibrous bands, admitted the possibility of strangulation by fibrous rings in the fascia cribriformis.

The fibrosis we are chiefly concerned with is the narrow, tough, circular ring limited to the neck of the sac, while the remainder of the sac, no matter how large, how recent or old, with or without previous truss pressure, is smooth and normal in appearance. The process can be well termed fibrous peritonitis. As already suggested, it must be obvious that such circumscribed fibrosis cannot be pyogenic in origin and not leave any traces of inflammation on the rest of the sac surface. It occurred to us that this formation must be traumatic in origin, very likely due to repeated muscular contractions of the internal ring, a kind of traumatic peritonitis. The mechanical factor must be sought for in the repeated contractions of the conjoined muscle, a purely nervous mechanism against the fixed Poupart's ligament, acting as a "shutter" against the intra-abdominal pressure (Keith). Babcock utilized this principle in obliterating the internal abdominal ring by suturing the internal oblique and transversalis muscles to Poupart's ligament. He disagrees with Connell, Marsh Pitzman, and Edmund Andrews, who advocate reducing the size of the internal ring. The criticism of Andrews and Connell that the sphincteric action of the internal oblique is lost by suturing it to Poupart's ligament is not tenable according to Rosenblatt and Coaksey, who believe that by so doing, one actually keeps the "shutter" closed.

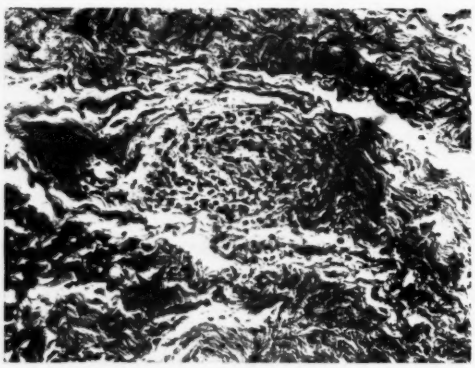

Fig. 5. Same section as Figure 4 highly magnified. (Note perivascular round cell infiltration.)

While in search for a better explanation of the production of this fibrous ring on a traumatic basis, there appeared at this juncture a well documented article by W. W. MacGregor, of Detroit, who describes "a true internal inguinal sphincter." We welcomed this description and were hopeful that repeated, voluntary contractions of this "sphincter" could satisfactorily explain the circular fibrosis on traumatic grounds. According to MacGregor, "the inguinal sphincter in the dog operated on was found to be a well defined, ring-shaped body of muscle fitting snugly around the cord where the latter dropped into the abdominal cavity through the origins of

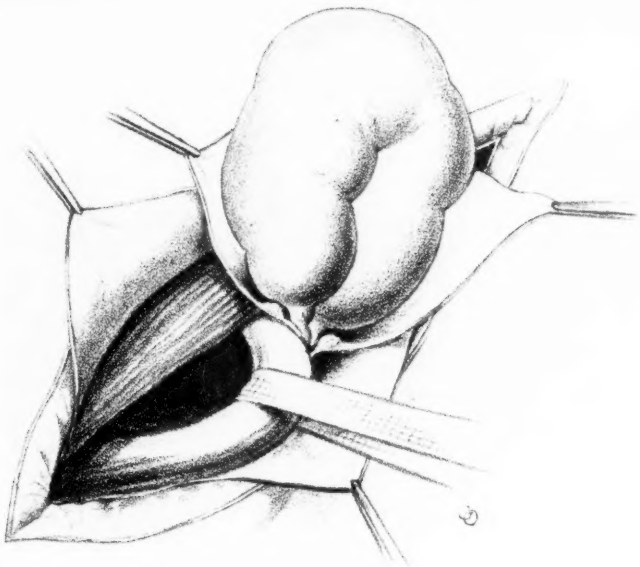

Fig. 6. Marked distention of intestinal loop caught in a tight ring.

the internal oblique and transversalis muscles." He found a similar sphincter in man and states: "It is our contention that the sphincter is demonstrable in all normally developed individuals," "although it was nowhere reported in the literature." The sphincter, thus described, has an independent nerve supply and when stimulated contracts circularly, sufficiently to "diminish markedly the bleeding from a cut in the spermatic artery." Microscopically, the sphincter shows evidence of skeletal muscle.

Although the sphincter of MacGregor suited our purpose admirably, we resolved to get acquainted with the structure and see to what extent it could mechanically explain a traumatic peritonitis with ultimate fibrosis of the neck. We dissected four old cadavers, three fresh ones, the fresh cadaver of a child, and ten dogs, making a total of sixteen inguinal regions in man and twenty in dogs. We readily admit the insufficiency of our anatomical material. In all our dissections, we merely found that the upper and lateral margins of the internal ring were bounded by the arched fibers of the internal oblique and transversalis muscles. These fibers frequently grouped themselves in two or three distinct circular columns, arching over the cord, especially in dogs. In two or three instances, it looked as though they were separated from the main

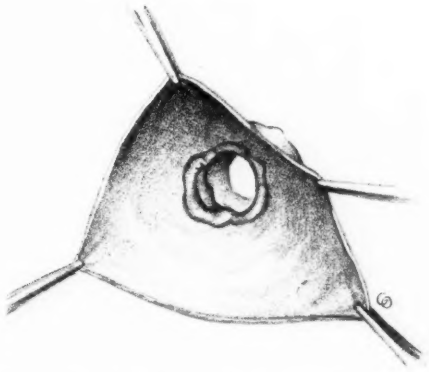

Fig. 7. Complete circular ring at neck of sac, showing normal peritoneal surface in rest of sac. (Drawn from actual specimen.)

muscles. At no time, however, did these circular columns completely surround the cord. Whenever there was a suggestion of a complete circumference, it was invariably found that the lower half was nothing more than cremasteric fascia and muscle, plus the infundibular fascia and, as such, they had no connection with the upper circumference. The arched muscular fibers, even though they do not constitute a complete circumference, undoubtedly are capable of completely shutting off the internal ring and the only credit they are entitled to is that of a "shutter-like" or "sphincter-like" action as observed by Keith, Hammond, Darling, and others. Even on purely theoretical grounds, it was difficult for us to conceive the presence of a sphincter at the internal ring. Throughout the entire human anatomy we cannot find an example of a true sphincter, except in tubular or hollow organs. Again, it was scarcely consistent with the prudence and wisdom of Nature to imagine a tiny sphincter entrusted with the task of opposing a mighty intra-abdominal pressure. Finally, it would be difficult to conceive a sphincter powerful enough to resist the intra-abdominal pressure, completely encircling the cord and not to compress the vessels of the cord during contractions, either to the extent of chronic venous stasis or arterial ischæmia.

We are, therefore, compelled to accept merely the "shutter-like" action of the internal oblique and transversalis muscles, perfectly competent of closing the internal ring. Repeated, physiological contractions of these muscles upon the neck of the sac, we are inclined to speculate, cause a kind of aseptic, traumatic peritonitis, finally expressed in a circular fibrosis at the neck of the sac.

CONCLUSIONS

1. Fibrous peritonitis at the neck of hernial sac is a rather common occurrence.

2. The etiology of this circular fibrous ring at the neck of the sac is, very likely, an aseptic, traumatic peritonitis, the result of repeated muscular contractions at the internal ring.

3. Fibrous peritonitis is responsible for a number of strangulations, the degree of damage being proportionate to the toughness of the ring and the narrowness of the lumen at the neck of the sac.

4. Reposition of viscera in severe strangulations, frequently requires preliminary division of the fibrous ring, both as an aid in replacement and as a safeguard against mechanical damage to the bowel wall and its mesentery.

5. We are unable to identify the internal sphincter of MacGregor, which may be due either to our inexpertness in dissection or insufficient anatomical material.

6. The internal oblique and transversalis muscles exert a "shutter-like," possibly a "sphincter-like" action, which satisfactorily opposes the intra-abdominal pressure.

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EXPERIMENTAL STUDIES OF THE EFFECT OF AMYTAL UPON THE FETUS AND ITS TRANSMISSION THROUGH THE PLACENTA OF THE WHITE RAT

CHARLES M. BOUCEK, M.D., PITTSBURGH
Department of Anatomy, The School of Medicine, University of Pittsburgh, and St. John's General Hospital, Pittsburgh
AND
ARTHUR D. RENTON, PITTSBURGH
Department of Anatomy, The School of Medicine, University of Pittsburgh

WITH the advent of the increasing use of sodium amytal in obstetrics and in animal experimentation involving the fetus, the placental transmission of this anæsthetic has become a problem of interest. In a parturient woman, two lives are affected and any means used to relieve or abolish the pains of labor must harm neither the mother nor the child. The widespread use of sodium amytal in experimental work, in which observations upon the fetuses are to be made, has necessitated a complete study of the effects of this barbituric compound upon the fetuses of mothers anæsthetized with it.

Drabkin, Ravdin, Hirst, and Lapham (1929), working with sodium amytal anæsthesia in obstetrics, reported a series of cases in which they found that the babies of mothers kept under sodium amytal anæsthesia during parturition were not narcotized when born, nor did they show any other effects of the drug, but cried lustily immediately after birth. In only two instances were the babies slightly asphyxiated. In these cases the asphyxiation was attributed to difficult delivery. In their entire series, the fetal heart rate was found to be unaltered. Robbins, McCallum, Mendenhall, and Zerfas (1929) arrived at much the same conclusion after a detailed study of 80 cases. They concluded that there was no danger to the baby in sodium amytal anæsthesia. In their series, 3 babies were asphyxiated and 2 were apnœic when born, while the remainder breathed spontaneously or after slight stimulation. In most of the apnœic and asphyxiated cases, the labors were long or forceps were applied. The fetal heart rates varied within normal limits, and the size of the dosage bore no relation to the degree of variation.

So far we have been unable to collect any data from experiments and observations of other investigators working with sodium amytal or from our own to show that there is any danger to the fetus when the mother is anæsthetized with this drug. Our experiments with sodium amytal in pregnancy in the white rat, and in the study of the transmission of this crystalloid substance from mother to fetus and from fetus to mother in this animal, have given us further proof that the placenta of the white rat acts as an organ or an organ system which selects and rejects substances that might pass through it. The fact that sodium amytal is readily transmissible from fetus to mother but not from mother to fetus warrants this conclusion.

MATERIALS AND METHODS

White rats (mus norvegicus albinus) were used in these experiments. They were selected from the rat colony of the Department of Anatomy of the University of Pittsburgh.[1] This stock of rats has been under colonization for experimental purposes for the past 7 years. The male animals and non-pregnant females employed as controls for the dosage of sodium amytal were young adult animals. The pregnant females were selected without reference to the age of the animal, although, when possible, those having previously given birth to one or more litters were used. For the first group of experiments pregnant animals with relatively large fetuses were used; for the second group, including the control experiments, pregnant animals between the eighteenth and twentieth day of gestation were selected; and for the third group, females between the fifteenth and twentieth day were employed.

A 2 per cent solution of sodium amytal (sodium iso-amyl-ethyl-barbiturate) was used.

[1] We wish to express our appreciation for the helpful suggestions of Doctor Davenport Hooker and Doctor John C. Donaldson of the Department of Anatomy of the School of Medicine, University of Pittsburgh.

The solution was prepared according to the method described by Mulinos (1928) from the insoluble crystalline iso-amyl-ethyl-barbituric acid.[1] The insoluble acid was suspended in distilled water, 5 cubic centimeters for each gram. The mixture was gently heated in a water bath and frequently shaken during the addition of 15 per cent sodium hydroxide, drop by drop, until solution was complete. The solution was then diluted to 10 cubic centimeters for each gram of material used. The resulting solution of sodium amytal (10 per cent) was kept in a glass stoppered bottle as the stock solution. It was subsequently diluted with distilled water to a 2 per cent solution just before using.

A newly prepared solution was always allowed to stand at least 3 days before being used, due to the fact that it causes undue irritation to the animal if injected before that time. This observation has been reported previously by Mulinos (1928). The solution showed a tendency to become cloudy or opalescent after 1 to 6 days. According to Zerfas, McCallum, Shonle, Swanson, Scott, and Clowes (1929), this is due to the precipitation of the insoluble acid in fine crystals brought about by the lowering of the hydrogen-ion concentration from the limits of 9.8—9.5 to 9.2 or lower. A solution of this type was found to exert a toxic effect upon the respiratory center, as shown by various irregularities in respiration. For this reason, the solution was always filtered before it was used. Stock solutions of 10 per cent sodium amytal can be kept in a tightly stoppered bottle for several weeks without becoming toxic or losing their anæsthetic properties (Lieb and Mulinos, 1929).

The optimum dosage required for the production of complete anæsthesia was found to be about 80 milligrams per kilogram of body weight. The exact amount necessary was accurately calculated from the weight of the animal. After the initial experiments the estimated weight of the fetuses was deducted from the mother's weight in determining the dosage.

[1] Since the completion of our work, Lilly and Company has placed on sale a preparation of sodium amytal, which Lieb and Mulinos found to have the same anæsthetic properties with no greater toxicity than their own preparations of this substance.

The technique employed in administering sodium amytal to the mothers and in stimulating the fetuses was as follows:

1. The animal was put under light ether anæsthesia in order to facilitate weighing and injection of the sodium amytal.

2. The calculated amount of 2 per cent sodium amytal was injected intraperitoneally, a 1 cubic centimeter Luer tuberculin syringe and a 27 gauge needle being used, while the animal was recovering from the ether anæsthesia. Care was taken to avoid the uterine horns during injection of the sodium amytal.

3. After the animal had been under complete amytal anæsthesia for 10 to 15 minutes, the abdomen was opened. A needle was then inserted diagonally through the uterine wall and fetal membranes, and the fetus stimulated by the prick of the needle. The fetuses were stimulated every 15 minutes during the period of anæsthesia of the mother, and their responses observed. This routine was followed for a series of 25 pregnant animals under amytal anæsthesia.

In a second series of 25 pregnant animals, the fetuses were again stimulated at 15 minute intervals as above. In addition to this, one fetus was removed every 15 minutes, and tested for reactions by lightly touching the surface of the body with a needle.

The technique employed in the administration of 2 per cent sodium amytal to the fetuses was as follows:

1. The mother was put under light ether anæsthesia, weighed, and her fetuses palpated to determine their approximate weight.

2. The amount of amytal to be used was calculated on the basis of the weight of the mother minus the estimated weight of the fetuses.

3. The abdomen was then opened and the uterine horns carefully lifted out of the abdominal cavity.

4. By means of a 1 cubic centimeter Luer tuberculin syringe with a spring attachment and a 27 gauge needle, the calculated amount of 2 per cent sodium amytal was injected into the abdominal cavities of the fetuses. The injection was done very carefully, the needle piercing the walls of the uterus, the fetal membranes, and the abdominal walls of the fetus

at an oblique angle. The perforations through each of these coverings were staggered, so as to prevent leakage after the needle was withdrawn. The necessary amount was equally divided among all the fetuses.

5. The abdomen of the mother was then closed, during which time the animal was allowed to recover from the ether anæsthesia.

6. Observations were then made of the time taken for the sodium amytal to produce partial and complete symptoms of anæsthesia in the mother.

7. The animal was autopsied 2 or 3 days later to determine the effect of the injected sodium amytal upon the fetuses.

The technique of injecting 2 per cent sodium amytal into the amnia corresponded closely with that just described for the fetuses, the difference being that the anæsthetic was introduced into the amniotic sac instead of into the abdomen of the fetus.

EXPERIMENTS

The experiments may be divided into three main groups: (1) preliminary experiments to determine the anæsthetic dose of sodium amytal for a pregnant animal; (2) experiments showing the effect upon the fetuses of anæsthesia of the mother with sodium amytal; (3) experiments showing the effects upon the mothers of injections of fetuses with sodium amytal.

The first group of experiments was made necessary by the fact that the calculation of an anæsthetic dose of sodium amytal is different in pregnant from that in non-pregnant animals. The second group, concerned with the fetuses of mothers anæsthetized with sodium amytal, comprises two series. Series I pertains to the stimulation of fetuses *in utero* of mothers anæsthetized with sodium amytal, and Series II concerns the stimulation of fetuses *in utero* followed by the stimulation of the fetuses after their removal from the uterus. The third group is also divided into two series: Series III, the injection of sodium amytal into the abdominal cavity of the fetus, and Series IV, the injection of sodium amytal into the amniotic sac of the fetus, in each case to determine its time of absorption and possible transmission through the placenta.

The first group of experiments may be considered as a preliminary group and a set of experiments that was made necessary due to the fact that when work was first started on this problem about 60 per cent of our pregnant animals received lethal doses of sodium amytal when injected with the usual dosage calculated from the weight of the animal. In these first experiments the pregnant animal was weighed and the amount of sodium amytal necessary to anæsthetize it was calculated from the weight of the animal (80 milligrams per kilogram). These animals became completely anæsthetized in 2 to 5 minutes and 60 per cent of them died in from 10 to 35 minutes (Table I, Nos. 1 to 5). It appeared that either our solution was too strong or our calculated dose was in error. Rechecks of our solutions (Table I, Nos. 11 to 16) and further work showed that our results were due to failure to allow for the weight of the fetuses. Evidently these played no part in the absorption of the drug and their weight, when not considered, was sufficient in the majority of cases to cause the dose to be lethal. Each solution of sodium amytal may vary slightly in toxicity and anæsthetic properties from day to day and, unless controlled daily, even the excess weight of the fetuses will cause untoward results. From this observation alone, we suspected that the placenta was acting as a barrier to sodium amytal, thus causing our original dose of the anæsthetic within the body of the mother to be lethal.

A number of experiments were then made in which the animals were weighed, the estimated weight of the fetuses subtracted from the weight of the pregnant animal, and the amount of sodium amytal necessary to anæsthetize it calculated from the approximate weight of the animal minus the weight of the fetuses. In all cases in which this routine was followed, the animal survived (Table I, Nos. 6 to 10). In subsequent experiments, the dose of sodium amytal was calculated from the weight of the mother minus the estimated weight of the fetuses.

Before working on the second group of experiments (the effect upon the fetuses of sodium amytal anæsthesia of the mothers), controls were made to test fetal susceptibility to

TABLE I

No.	Weight of pregnant animal (grams)	Estimated weight of fetuses (grams)	Estimated weight of mother minus weight of fetuses (grams)	Weight of non-pregnant female, or male (grams)	Amount of amytal. .80 c.cm. per 200 gram. (80 mgm. per kilo)	Results
1	215	Not taken into consideration	Not taken into consideration		0.86	Died
2	170	Not taken into consideration	Not taken into consideration		0.68	Died
3	158	Not taken into consideration	Not taken into consideration		0.64	Died
4	205	Not taken into consideration	Not taken into consideration		0.82	Anæsthesia with complete recovery
5	230	Not taken into consideration	Not taken into consideration		0.92	Anæsthesia with complete recovery
6	185	20	165		0.66	Anæsthesia with complete recovery
7	228	22	206		0.82	Anæsthesia with complete recovery
8	192	18	174		0.70	Anæsthesia with complete recovery
9	203	22	181		0.72	Anæsthesia with complete recovery
10	225	25	200		0.80	Anæsthesia with complete recovery
11 (control)				200	0.80	Anæsthesia with complete recovery
12 (control)				208	0.83	Anæsthesia with complete recovery
13 (control)				170	0.68	Anæsthesia with complete recovery
14 (control)				175	0.70	Anæsthesia with complete recovery
15 (control)				230	0.92	Anæsthesia with complete recovery
16 (control)				170	0.68	Anæsthesia with complete recovery

sodium amytal by injecting small doses directly into the fetuses *in utero*. The procedure was as follows:

1. The mother was put under light ether anæsthesia and her abdomen opened.

2. One fetus was removed and its exact weight determined.

3. The dosage of sodium amytal (2 per cent) required for a single fetus was then calculated, using the same basis as that used for adult animals (80 milligrams per kilogram).

4. The remaining fetuses were injected as follows: (a) two fetuses were given one-fourth of the calculated amount, (b) two fetuses were given one-half of the calculated amount, (c) two fetuses were given the calculated amount, (d) two fetuses were given double the calculated amount, (e) the remaining one to three fetuses were left uninjected.

The fetuses were removed from the uterus after 15 minutes and lightly stimulated by stroking or pricking with a needle. Those injected with one-fourth the amount of solution were little affected and responded readily to this stimulation; fetuses injected with one-half the amount showed a noticeable decrease in response; when the full amount was given there was no response; and when double the dose was injected, the fetuses were killed. These results indicate that the fetus is susceptible to sodium amytal in about the same degree as, or possibly a little more than, the mother.

With these data available, it was possible to proceed with the experiments in Group II, the aim of which was to determine the effect upon the fetuses of maternal anæsthesia with sodium amytal. Pregnant animals were given

TABLE II[1]

Number	Wt. of pregnant animal	Estimated wt. of fetuses	Estimated wt. of animal minus fetuses	Amt. of sodium amytal based on 80 mgm. per Kilo	No. of fetuses	Age of fetuses—days	No. of fetuses injected	No. of amniotic sacs injected	First sign of anæsthesia in minutes	Complete anæsthesia in minutes	Condition of fetuses	Condition of mother
1	220	20	200	0.80 c.cm.	8	15	8		3 min.	25	Dead	Recovery
2	225	25	200	0.80 c.cm.	8	18	8		Direct ether to amytal anæsthesia	15	Dead	Recovery
3	205	5	200	0.80 c.cm.	1	20	1		5 min.	40	Dead	Recovery
4	245	35	210	0.84 c.cm.	11	18	10		Immediately	15	Dead	Recovery
5	165	15	150	0.60 c.cm.	3	20	3		3 min.	20	Dead	Recovery
6	225	10	215	0.86 c.cm.	8	18	3		Immediately	1	Dead	Recovery
7	143	15	128	0.51 c.cm.	6	15		6	8 min.	Never complete anæsthesia	Dead	Recovery
8	235	10	225	0.90 c.cm.	2	20		2	10 min.	26	Dead	Recovery
9	151	20	131	0.52 c.cm.	7	16		6	Direct ether to amytal anæsthesia	Direct ether to amytal anæsthesia	Dead	Recovery
10	179	14	165	0.66 c.cm.	8	15		6	2 min.	4	Dead	Recovery
11	220	25	195	0.78 c.cm.	8	18		6	5 min.	12	Dead	Recovery

[1]The injection of sodium amytal into the fetuses and amniotic sacs of fetuses to determine the absorption permeability of the placenta to sodium amytal when injected into fetuses and amniotic sacs of fetuses.

a light ether anæsthesia, and the calculated amount of sodium amytal was injected into the peritoneal cavity of the mother, care being taken to avoid the pregnant uterine horns. At 15 or 30 minute intervals, during the period the mother remained under the anæsthetic, the fetuses in the first series of 25 pregnant animals were stimulated *in utero* with a hypodermic needle, which was inserted diagonally through the uterine wall and fetal membranes. In all instances the fetuses responded and, in most cases, violently, even to the slightest stimulation. Care was taken to use only fetuses between the ages of 18 and 20 days of gestation, since Angulo (1929) stated that fetuses of the fourteenth day after insemination, or earlier, are non-motile, motility and response to stimulation beginning about the fifteenth day. He further concluded that, at about 19 days, the fetuses are roughly comparable in motility to newborn rats and are capable of discrete reflexes.

In the second series of 25 pregnant animals, the fetuses were stimulated at 15 minute intervals and, in addition, a fetus was removed every 15 minutes during the time the mother remained under the sodium amytal. The umbilical cord was tied and cut, and the fetus examined and tested with light strokes of a needle for movements or reactions. In all cases, they responded to this stimulation. When the fetuses were delivered from the uterine cavity and the umbilical cord tied and cut, they often became very active and gasped for air, thus showing that they could not be under the effects of the anæsthetic.

The conclusion drawn from the entire second group of experiments is that the crystalloid substance, sodium amytal, does not pass the placenta from mother to fetus in large enough quantities to be detected by these gross experimental methods.

The third group of experiments, which was performed to determine the transmission of sodium amytal from fetus to mother and the time of its absorption and transmission, was divided into two series. In Series III, pregnant animals were weighed, the weight of the fetuses estimated and subtracted from the weight of the mother, and the amount of sodium amytal necessary for complete anæsthesia of the mother calculated from the corrected weight. This dose was then injected into the abdominal cavities of the fetuses, the amount being equally divided among them. In Series IV, the same routine was followed

as for the third, except that the sodium amytal was injected into the amniotic sac instead of into the abdominal cavity of the fetus. The results of these experiments are shown in Table II.

The chief aim of this group of experiments was to determine whether or not sodium amytal passed through the placental barrier from fetus to mother. It can be seen from Table II that, in all cases when sodium amytal was injected into the abdominal cavity of the fetus or into the amniotic sac, the anæsthetic readily passed through the placental barrier from fetus to mother, causing complete anæsthesia of the mother within a short time. In all cases, just sufficient sodium amytal was injected into the fetuses or amniotic sac to produce complete anæsthesia of the mother. Therefore, the greatest part, if not all, of the sodium amytal, must have been eliminated by the fetus and passed through the placenta. Further support for this conclusion was obtained from the results of control experiments carried out to determine the effect upon the mother when the fetuses were injected with a dose calculated as lethal for the adult rat.

The procedure was as follows: (1) The mother was put under ether anæsthesia. (2) The abdomen was opened and the uteri exposed. (3) The fetuses were then injected with a dose calculated as lethal for the mother (150 milligrams per kilogram) as reported by Drabkin, Ravdin, Hirst, and Lapham (1929). (4) The uteri were replaced in the abdominal cavity, the latter was closed, and ether anæsthesia was discontinued.

The following results were noted:

1. In all cases, the mother passed directly from ether into sodium amytal anæsthesia.

2. Death resulted in 5 minutes to ½ hour in 75 per cent of the cases.

Therefore, the conclusion that sodium amytal is practically entirely eliminated by the fetuses and passed through the placenta into the mother receives further substantiation from these results.

The third group of experiments demonstrates that sodium amytal is absorbed both from the abdominal cavity and from the amniotic sac of the fetus with relative rapidity and, perhaps *in toto*, passed through the placenta to cause complete anæsthesia of the mother.

DISCUSSION

These experiments show that in the white rat sodium amytal passes through the placenta more readily in one direction than in the other. This substance passes with difficulty and perhaps not at all from mother to fetus, yet readily passes from fetus to mother. The conclusion that sodium amytal does not pass in quantity from mother to fetus is based upon two experimental facts: (1) the dose of sodium amytal calculated from the total weight of the pregnant animal proved lethal for the mother in 60 per cent of cases, but doses calculated from the weight of the mother minus the estimated weight of the fetuses were never lethal; and (2) the fact that fetuses of pregnant animals, under amytal anæsthesia, showed no signs of being anæsthetized or in any way affected by sodium amytal. No chemical analysis was made of the sodium amytal content of the blood of the fetuses of mothers under this anæsthetic. No proof can be offered, therefore, that it does not pass in minute quantities. However, our experiments proved that it does not pass in large enough quantities to affect the fetus sufficiently to be detected by observation or by stimulation methods. This leads us to believe that sodium amytal, in doses just sufficient to anæsthetize the mother, does not pass from the mother to the fetus.

On the other hand, when sodium amytal was injected into the fetuses or into the amnia, it readily passed the placental barrier and in a short time caused complete anæsthesia of the mother. The dose injected into the fetuses, or amniotic sacs, was just sufficient to cause complete anæsthesia of the mother; therefore, the greatest part, if not all, of the anæsthetic must have passed from the fetus to the mother. This conclusion was further substantiated by the fact that when the fetuses were injected with a dose calculated as lethal for the mother, the latter died after a few minutes in 75 per cent of the cases.

These experiments add further evidence in favor of the conclusion drawn by Boucek (1928) that the placenta behaves as an organ or organ system which selects and rejects cer-

tain materials. Schlect (1907) concluded from his work on vitally stained chorionic cells that the chief function of these cells is to protect the fetus from toxic substances in the maternal blood stream. It is our opinion that the cells of the placenta are selective in character and that there is a mechanism, as yet unknown, which not only prevents harmful products from entering the fetus but reacts quickly to transfer harmful products from fetus to mother.

It is of interest to note the time of transmission of sodium amytal from the fetal tissue to that of the mother. When the solution was injected into several fetuses or amnia, the mothers often became anæsthetized almost, or quite, as quickly as did animals in which this anæsthetic was injected directly into the peritoneal cavity. The time that elapses before the mother becomes anæsthetized seems to vary with several factors. The most important appears to be the particular solution of sodium amytal used, since each solution differs somewhat in its anæsthetic properties. The age of the fetuses is another possible factor, but the present experiments do not warrant any conclusions as to its influence. The number of fetuses injected plays an important rôle. In one case, in which one fetus only was injected, the mother showed the first signs of anæsthesia in 5 minutes and was completely anæsthetized in 40 minutes (Table II, No. 3), which is about three times as slow as the rate obtained when the solution was injected directly into the peritoneal cavity of the mother. When a number of fetuses or amnia were injected, the time of anæsthesia of the mother diminished and, not infrequently, anæsthesia occurred as quickly as when the solution was placed in her abdominal cavity (Table II). It may be said that within certain rather indefinite limits, the time required for complete anæsthesia of the mother varies inversely with the number of fetuses or amnia injected, the age of fetus, and the particular solution used.

The question regarding the difference in the time of absorption and transmission of amytal injected into the fetuses and into the amniotic sacs was considered. However, due to the fact of the variation in anæsthetic properties of different solutions of sodium amytal, we did not standardize our methods by injecting the same number of fetuses or amniotic sacs at the same age. Therefore, these experiments present insufficient data from which to draw definite conclusions concerning this question. At the present time, we are working on this phase of the problem, using dye solutions which have a more uniform composition, and we find, as we have suspected from observations on animals injected with sodium amytal, that the absorption and transmission of solutions from the amniotic sac is slower than from the fetal tissues.

One observation, not concerned directly with this problem but with sodium amytal anæsthesia in general, has come to our attention several times during our work with this anæsthetic. We have noticed that the calculated dose of amytal did not always cause complete anæsthesia of the animal. In such cases the animals, when undisturbed, appeared to be completely anæsthetized. When operative procedures were begun, however, they became restless and attempted resistance. If these animals were given a few whiffs of ether, they became completely anæsthetized and remained under sodium amytal anæsthesia for the usual length of time without further use of ether. Mason and Baker (1930), working with sodium amytal on man, have reported similar observations. They state that this anæsthetic gives the best results when supplemented with others, either general or local.

CONCLUSIONS

1. The amount of sodium amytal necessary to anæsthetize a pregnant rat does not in any way interfere with the viability of the fetus; the fetus is not anæsthetized and readily responds to gross stimulation.

2. Sodium amytal quickly passes from the fetal circulation into the maternal circulation.

3. In calculating the amount of sodium amytal necessary to anæsthetize a pregnant animal, the weight of the fetuses must be subtracted from the weight of the mother.

4. The anæsthetic value of sodium amytal may be enhanced when supplemented with small quantities of ether.

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CLINICAL SURGERY

FROM THE GRADUATE SCHOOL OF MEDICINE, UNIVERSITY OF PENNSYLVANIA

OPERATIVE TREATMENT OF LOSSES OF SUBSTANCE OF THE MANDIBLE, WITH SPECIAL REFERENCE TO FIXATION OF EDENTULOUS FRAGMENTS

ROBERT H. IVY, M.D., D.D.S., F.A.C.S., AND LAWRENCE CURTIS, A.B., M.D., D.D.S., PHILADELPHIA

PERMANENT loss of substance of the mandible may be the result of trauma (comminuted fracture from gunshot wound or other injury), osteomyelitis and necrosis, or surgical removal of a part of the bone on account of a tumor or other pathological condition. This loss of substance, after arrest of disease and healing of the soft tissues have taken place, causes a more or less marked disability, according to the location and extent of the defect, the presence of adhesions, and the number of teeth missing. Where the bone loss involves the lateral portion of the mandible, the fragment on the sound side is drawn over toward the defect so that the teeth lie too far within those of the upper jaw. In most cases this main mandibular fragment is bound over to the smaller fragment by scar tissues so that complete reduction to normal position by manipulation is generally impossible. Occasionally, however, mobility is quite free, and the normal space between the fragments can be easily obtained by manipulation. The resulting malocclusion of the teeth and instability of the fragments renders the mastication of solid food difficult or impossible. In addition, marked external deformity is noted. The chin deviates to the affected side, and there may be a concavity in the cheek on this side due to upward and inward displacement of the small bone fragment behind the defect.

If the loss of substance is at the symphysis of the mandible, the normal horseshoe shape of the bone will be converted into a V. The contracture in front will cause a bilateral drawing in of the lower teeth, so that they will bite far within those of the upper jaw. Here again we note a crippling of the mastication and a narrowing of the lower part of the face.

In the preliminary treatment of these defects prior to bone grafting to restore the bone loss, if there are several sound teeth in each fragment the problem of fixation in normal position by means of wires or splints to the upper teeth is comparatively simple. But the absence of teeth in either or both mandibular fragments or in the upper jaw greatly complicates the treatment of these deformities.

The condition which we particularly wish to discuss here, is a healed unilateral defect of the premolar and molar region of the mandible, with a loss of about one and a half inches of bone, with several sound teeth in the large fragment and the upper jaw, but none in the smaller mandibular fragment posterior to the defect. As a consequence of the absence of teeth to oppose those of the upper jaw, the anterior end of this small fragment is pulled upward by the levator muscles attached to it, so that its lower border, instead of being horizontal, points forward and upward at a marked angle, and the gum covering its upper border meets the teeth of the upper jaw (Fig. 1). The anterior end of this fragment may also be drawn toward the median line, producing a concavity in the side of the face. Many more or less complicated schemes have been devised for keeping this posterior edentulous fragment down in position. One plan that has frequently been tried is the use of a metal or vulcanite saddle splint resting on the soft tissues over the edentulous fragment and attached in front by caps to the teeth of the larger mandibular fragment. It has been found that the pressure exerted by these saddles often causes irritation, pain, ulceration, and even sloughing of the soft tissues covering the bone. Others have used a sharp forked metal extension which punctures the gum and penetrates the bone superficially. This appliance is difficult to construct, and the penetration of the bone and soft tissues from the mouth frequently leads to infection. The *nail*

Fig. 1. Diagram of lateral mandibular defect, showing displacement of fragments.

extension principle has been applied to these cases by Lindemann (1). The angle of the mandible is exposed through a small skin incision, a hole is drilled through the bone, and a special bolt passed through the hole and fastened with a nut. The end of the bolt extends out through the skin incision. Control of the bone fragment is thus achieved by making traction on the bolt in a backward and downward direction by an elastic band whose other end is connected with a plaster-of-Paris head cap or with a bar running backward outside the cheek from a cap splint on the teeth. These methods are all complicated and require highly specialized dental technique. What is needed for these cases is a simple but efficient method of control easily applicable by the surgeon at the time of operation without previous elaborate dental technique. Darcissac (6), in a case of double fracture of the mandible posterior to the last tooth on each side, to hold down the short posterior fragments, drilled a hole through each angle, passed a silver wire through the hole in the bone, bringing the ends out through the skin incision. Backward and downward traction on the posterior fragments was made by connecting the two wires with a heavy elastic band around the back of the neck. We employ a similar simple application of the nail extension principle in controlling the edentulous posterior fragment in the mandibular defects under consideration.

Fig. 2. Exposure of angle of mandible through skin incision.

The treatment of this type of case divides itself into two principal stages: (1) preliminary reduction and fixation of the fragments in normal position, (2) restoration of the continuity of the mandible by bone graft.

Preliminary reduction and fixation of the fragments in normal position. Before anæsthetizing the patient for the operative procedure, a plaster-of-Paris cap must be made for the head to provide a means of fixation for the edentulous fragment of the mandible. In this we follow the technique of Scogin (7), whereby a comfortable and firm head cap is produced. The materials required are: (1) stockinette 3 inches wide by 2 feet long; (2) narrow gauze bandage 1 foot long; (3) adhesive plaster 1 inch wide; (4) orthopedic felt, 4 strips 1½ inches wide and 6 inches long; (5) plaster-of-Paris bandage, 2½ inches wide; (6) heavy iron wire, such as an ordinary wire coat hanger.

Construction steps. (1) The patient is seated in a chair and draped with a sheet; (2) in men, if the case is to require lengthy fixation, the hair is clipped—otherwise not necessary. Women are requested to braid the hair and arrange it in a loose coil at the top of the head; (3) one end of the stockinette is applied over the head to a point 2 inches below the border of the finished cast; (4) a gauze bandage is tied loosely around the stockinette at the top of the head; (5) felt strips are cut and adjusted one in each quadrant of the head, and are fastened in place on the stockinette, with adhesive plaster; (6) the free end of the stockinette is pulled down over the head and trimmed just short of the first layer. Felt strips are now between the layers of the stockinette; (7) a wet plaster-of-Paris bandage is applied over the stockinette, and is smoothed into place; (8) the edges of both layers of stockinette are turned up to form the lower border of the cap, and are plastered smoothly into bandage;

Fig. 3. Hole being drilled through mandible near angle.

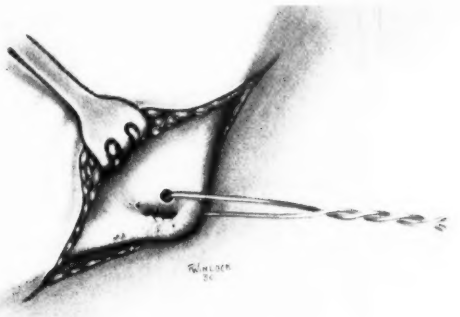

Fig. 4. Brass wire passed through hole at angle of mandible.

(9) a piece of iron coat hanger wire is bent to fit the side of the head against the plaster bandage, the hooked end being allowed to project downward behind the ear on the side of the jaw fragment to be controlled; (10) a second plaster bandage is applied, it being worked well around and over the wire to hold it firmly in place. The lower half inch of stockinette is left exposed below bandage to produce a smooth rounded border. The finished head cap is shown in Figure 5. Provision for fixation of the larger mandibular fragment is now made by application of two or three pairs of brass eyelet wires to the lower and corresponding upper teeth. Each pair of upper and lower eyelets is connected by a third wire, holding the teeth in occlusion. The method has been described many times (2, 3). If a sufficient number of sound teeth are present in both jaws, this method gives adequate fixation, and is very much simpler than the use of special splints. In case the teeth are not sufficient in number and stability for direct application of eyelet wires, we employ arches made of half-round German silver wire. A piece of this is molded to conform to the vestibular surfaces of the lower teeth and attached to these with 24 gauge brass wire ligatures. A similar arch is applied to the upper teeth and the upper and lower arches are fastened together with the brass ligature wires. If desirable or necessary, the attachments can be made to the teeth at this time, and the connecting of the upper and lower teeth postponed until after operative reduction. However, if reduction of the main fragment and restoration of occlusion of the teeth is possible before operation, there is no objection to fastening the teeth together immediately. We have never seen any difficulty from general anæsthesia in these cases where the teeth are fastened together.

The patient is now etherized by intraoral or intrapharyngeal vaporization. The first step of the operation is free mobilization of the larger fragment so that the teeth can be easily brought into occlusion with those of the upper jaw. To bring this about it may be necessary to cut bands of scar tissue within the mouth between the two fragments. The upper and lower teeth are then fastened firmly in occlusion. This enables the operator to judge better the amount of reduction necessary to bring the posterior edentulous fragment into position. After working in the mouth, the surgeon should put on fresh gloves before proceeding with the extraoral part of the operation. An oblique skin incision, slightly convex downward, about 3 centimeters in length, is made at the angle of the mandible. The deeper tissues are divided or pushed away by blunt dissection to expose the bone at the angle both externally and internally over an area of about 2 centimeters in diameter (Fig. 2). A broad, thin elevator is passed beneath the angle to raise and support it while a small hole is drilled through it. The hole is drilled at a point about 1.5 centimeters from the edge of the bone (Fig. 3). Two strands of No. 24 gauge soft brass wire 12 inches long are twisted together. This double strand is then passed through the hole in the angle of the mandible (Fig. 4). With this wire, downward and backward traction is made on the bone. If the bone fragment does not come into proper position it must be thoroughly freed from scar tissue connections by scissors inserted in the incision. Perforation into the mouth through the mucous

Fig. 5. Wire from angle of mandible connected with hook on plaster-of-Paris head cap by elastic band, making traction on edentulous posterior fragment.

membrane should be avoided if possible, because if it occurs a longer time is required for healing, and infection may take place along the wire. However, it is essential at all costs to free thoroughly the mandibular fragment at this time so that complete reduction is possible by downward and backward traction on the wire. The ends of the wire are twisted together outside the wound and connected to the hook on the plaster head cap either directly or by means of a heavy elastic

Fig. 7. Plaster cap and traction wire from posterior fragment.

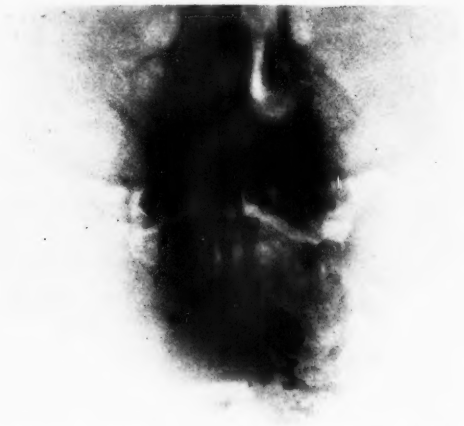

Fig. 6. Roentgenogram showing comminuted gunshot fracture of left side of mandible.

band (Fig. 5). The tension on the wire must be sufficient to keep the edentulous mandibular fragment down in position. The wound is closed with a few interrupted dermal sutures, without drainage, the wire emerging through its posterior end. It is covered with a small gauze dressing attached with adhesive plaster. Very little postoperative reaction occurs as a rule, especially if the oral mucous membrane has not been opened. The sutures are removed on the fifth day. By these procedures the two mandibular fragments are reduced and fixed in their normal positions, and the space between them corresponds in length to the lost portion of bone. It is now necessary to wait for a period of 2 to 8 weeks until healing of the soft tissues takes place, that is, until the ends of the bone fragments are safely sealed off from the mouth cavity and from external wound infection. The head apparatus and wires on the teeth remain in place during this time. The patient is fed on liquids through a tube. In many cases, where teeth are missing, semisolid and mashed foods can be taken.

Filling the mandibular defect by a bone graft. As soon as it is considered that the ends of the mandibular fragments are safe from infection from the foregoing operative procedure (2 to 8 weeks), the bone grafting operation to restore continuity is undertaken. In previous articles (4, 5) we have set forth the advantages of the crest of the ilium as a source of the mandibular bone graft. The crest of the ilium furnishes a large piece of bone, of porous structure, closely allied to that of the mandible, is easily penetrated

Fig. 8. Roentgenogram showing traction wire holding posterior fragment in position, also extent of mandibular defect.

Fig. 9. Roentgenogram showing bone graft from crest of ilium filling defect of mandible.

by new vascular supply, and can be readily cut to suitable shape. The disability produced by removal of the graft is quite temporary and the danger negligible. These points favor it over the usual thick graft from the tibia, which is dense, not easily penetrated by new vascular supply, is brittle and hard to trim to the desired shape, and its removal may be followed by fracture of the leg unless extreme postoperative care is used. In these defects of the lower jaw, there is no necessity for strength and rigidity of the graft itself, because the fragments are already held firmly by the fixation apparatus and there need be no dependence on the graft for immobilization.

The patient is etherized without disturbing the fixation apparatus on the bone fragments. The first step is exposure and preparation of the ends of the mandibular fragments. This is done before the graft is removed from the ilium in order that the size of graft required may be determined and also on account of the possibility of opening into the mouth while preparing the mandibular site—an accident which would render useless the graft at this time. A skin incision with convexity downward is made over the bony defect, and the skin flap is turned upward. A second flap, consisting of deeper tissues, is then turned up. Extreme care is taken to avoid opening into the buccal cavity. Scar tissue between the fragments is carefully removed and the ends of the bone are thoroughly exposed and beveled slightly to create broad freshened surfaces. A hole is drilled in the end of each fragment for the passage of a No. 24 gauge brass wire. Bleeding is arrested. The length of the gap is measured with a probe.

An incision is made along the crest of the ilium of the same side as the jaw defect, down to the periosteum, beginning at the anterior superior spine, back as far as necessary. The muscles attached to the outer and inner lips of the crest are stripped down, and a piece of bone is removed with a metacarpal saw, beginning at the anterior superior spine and working backward. The graft comprises the full width of the crest of the ilium and should be of sufficient length and depth to fill the gap in the mandible, allowance being made for slightly overlapping the mandibular fragments at each end. The detached muscles are brought over the site of removal of the graft and sutured together with chromicized catgut; the skin of the iliac wound is closed with dermal sutures. A small rubber tissue drain may be inserted for 24 hours.

Fig. 10. Patient after restoration of continuity of mandible, showing extent of mouth opening and no lateral deviation of lower jaw.

Any shreds of muscle are removed from the graft, but periosteum is allowed to remain. The ends are slightly beveled and holes drilled in them. The wires attached to the mandibular fragments are then passed through the holes and twisted so that the graft fits snugly in contact with the mandibular fragments. We prefer wire bone sutures to catgut or kangaroo tendon, because a very much firmer contact between the bones can be obtained. The ends of the wires are cut off short and turned over so that they will not project into the soft tissues. The wires usually remain permanently without causing irritation, but they can easily be removed later if desired. The layer of deeper soft tissues is sutured with catgut to cover the bone and the skin flap is closed with interrupted dermal sutures, usually without drainage.

Postoperative treatment. The wire fixation on the teeth is kept in place for about 12 weeks after the graft operation. It is generally not necessary to retain the traction on the posterior fragment for this length of time. Usually about 4 weeks after the operation the head cap and the traction wire can be removed. After 8 weeks the upper and lower teeth can be unlocked at intervals to permit gentle exercise and to stimulate bone consolidation. Union should be firm in about 3 months, after which it is usually possible to have the missing teeth replaced by an artificial denture.

The following is a brief description of a case illustrating the application of these principles:

H. H., male, aged 32 years, chauffeur, was shot with a large caliber pistol in August, 1929, the bullet entering the left side of the face, shattering the left side of the mandible, and remaining imbedded in the tissues (Fig. 6). An operation was performed at that time for removal of detached teeth, bone fragments, and bullet. In October an open-bite metal dental splint, with saddle resting on the gum over the posterior edentulous fragment, was inserted. By January, 1930, suppuration had ceased and the tissues had healed. The patient was referred to us by Dr. F. C. Bartleman of Newark, New Jersey, on March 27, 1930, for further treatment. At this time a gap of about 1½ inches was found on the left side of the mandible. This defect extended from just posterior to the left central incisor tooth to about the second molar region. There were no teeth in the bone fragment posterior to the defect. Only four teeth were present in the main mandibular fragment. The metal splint was still in position and the saddle resting on the gum kept the short posterior fragment down in place but there was ulceration of the soft tissues from undue pressure. On removal of the splint the main mandibular fragment was found to be freely movable and showed a tendency to swing over to the left side, throwing the teeth out of occlusion and causing marked external deformity (Fig. 1). The metal splint was discarded and the remaining lower teeth were brought into correct occlusion with the upper teeth and fastened by means of wire arches. The short posterior fragment was prevented from tilting upward by wire passed through the left angle and connected to a plaster-of-Paris head cap (Fig. 8). May 16, 1930, the gap in the mandible was filled by a bone graft from the crest of the ilium. June 20, 1930, the head cap and traction wire were removed. September 8, 1930, the wires connecting the teeth were cut and bone consolidation was practically complete (Fig. 9). The patient could open the mouth without any lateral deviation of the mandible (Fig. 10).

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FROM SURGICAL CLINIC, WASHINGTON UNIVERSITY MEDICAL SCHOOL

A CONCEPT OF THYROIDECTOMY TECHNIQUE OF TODAY[1]

WILLARD BARTLETT, M.D., F.A.C.S., AND WILLARD BARTLETT, JR., M.D., ST. LOUIS

IT should be the aim of the surgeon, in operating on a patient with goiter, to do just as much as the patient can withstand at one time. In his estimation of the risk involved by whatever procedure, ranging from merely transporting the patient to the operating room to complete subtotal thyroidectomy, lies the outcome of the case. If the surgeon underestimates the risk, the patient dies; if he overestimates it, the patient suffers the added pain and expense of having the operation unnecessarily divided into stages. Goiter patients do not die as often as they are killed, to put it plainly. However greatly he has increased his risk by delay in coming to the surgeon, the fact remains that the goiter patient who dies after operation is dead because too much surgery has been performed, regardless of what it was or why it was done. Since patients vary so widely in the picture they present and there is a corresponding variation in response to preparatory treatment, one must individualize by drawing on a variety of operative procedures and doing that one best adapted to the particular situation.

The choice of operation to be done is dictated with a view of the natural course of thyrotoxicosis. Our own patients rarely come to us in a relative remission of the disease. They come to us on the "down-grade," frequently only when they simply cannot carry on any longer. Where the surgeon errs most frequently in choosing to do too much to a seriously depleted patient is in losing sight of this fact. He forgets that the patient will probably get on the upgrade again if *not* operated on after the usual preparatory treatment at complete rest. He may increase his error by assuming that the goiter must be entirely removed during one hospital stay whereas the occurrence of a relative remission, when operation becomes safest, may be made more certain and even hastened by ligations in the very sick followed by a wait of 3 to 6 months.

It is our purpose here merely to outline the technique of those operations, other than subtotal thyroidectomy, which we find useful together with a brief mention of indications for their use, reserving detailed discussion for the subtotal or one-stage operation. Ligation is reserved for those patients, usually elderly, who clearly cannot be put in shape for even partial removal of the gland at the first hospital stay by reason of extreme emaciation or cardiac decompensation requiring digitalis for its control. Because the disease has usually been of long standing, subsequent remission can be hoped for only after a period of months during which they neither need, nor can they afford, hospitalization following ligation. Certain patients in young middle life will occasionally be seen in whom the pulse rate remains rapid, above 120, and the pulse pressure wide over a period of weeks of complete bed rest, though the basal metabolism may not remain high. They are "unknown quantities"; ligation is justified on them. We ligate only one side at a time; one ligation offers quite enough hazard to such patients. We have learned through bitter experience that because a patient has withstood any given operation it cannot be assumed that he will again withstand it on the following day or one week later. (So slight a procedure as ligation proved fatal August 30, 1930, to Mrs. McC. 5 days after she had passed through a first ligation with very little reaction.) We have not sufficiently realized that any operation may use up almost all of that mysterious quality, reserve, for an indefinite time. Accordingly, we completely evaluate our patient again before doing the second ligation. *This holds true for any division of thyroidectomy into whatever stages seem best.* It should hardly be necessary to reiterate that there is no "emergency surgery" in thyrotoxicosis; ligation has no place in the treatment of a dying patient. The patient who needs successive ligations is rarely in good enough nutritional or cardiovascular condition to withstand further attack directly on the goiter during that hospital stay. The maximum improvement ensues over a period of from 3 to 6 months. It is highly important to insist on further hospitalization and operation when the rate of improvement falls off, lest one delay too long and the patient once more gets on the down-grade.

Our preliminary medication is the same for ligation as for all other operations on the gland, i.e., a dose of one of the barbiturates, either by mouth, intravenously, or per rectum calculated in knowledge of the patient's metabolism, weight,

[1] Read by the senior author before the Medical Society of the Missouri Valley, Des Moines, October 16, 1930.

Fig. 1. The ultimate scar will be hidden by a fine chain.

and age, a tolerance test having been carried out previously. The dose is sufficient only to produce the state of "semi-anæsthesia," on which we have written elsewhere; no morphine is given, but the patient receives a hypodermic injection of atropine before operation. Nitrous oxid inhalation is employed as the final anæsthetic agent.

We locate the line of incision by searching for the slight depression that can be felt and usually seen between the apex of the pole and the lateral border of the larynx. The incision, of which the inner third lies over the larynx and the outer two-thirds over the thyroid tissue, is made laterally and slightly upward in a skin fold, if possible. It need not be over an inch in length; it is continued down through the platysma. The upper and lower borders of the incision are then retracted vertically and the deep fascia and ribbon muscles split longitudinally and retracted until the surface of the upper pole is recognized as it ascends and descends with swallowing. The pole is grasped with a hæmostat and lifted toward the operator; into the clearly defined groove between the pole and the larynx a curved Kocher ligature carrier is inserted, pointing laterally and slightly upward and gently passed behind the pole until its tip can be seen against the layer of deep fascia at the lateral and posterior border. This tissue is split, freeing the tip of the Kocher, a ligature of extra hard catgut inserted and the Kocher withdrawn. The double strand of catgut is tied, traction on the pole is released, and closure of the incision completed by one suture through the cervical fascia, two in the platysma, and two skin sutures. By this method one has tied the entire upper pole, including the vessels, nerves, and lymphatics. There are ordinarily no bleeding points to be tied as the operation is one carried out largely by blunt dissection. The complete procedure takes from 5 to 10 minutes.

There is a group of patients that, on preparatory treatment, does not get into entirely satisfactory condition for subtotal thyroidectomy, particularly if the latter operation promises to be extensive because of a large gland. These are regarded as uncertain risks in which one could not afford to have anything go wrong at operation, in which a bad "break" might seriously encroach on the margin of safety. In such cases we divide the operation, not into two lobectomies, but into two stages, the first of which is performed as follows:

The usual exposure of the goiter is carried out through a marked collar incision of skin and fat, longitudinal division of cervical fascia and splitting of ribbon muscles; the fascia is then cross cut for about 3 centimeters to each side of the midline at the level of the upper poles. The sternothyroid muscle is cross divided and allowed to retract. All bleeding points which have been caught are carefully ligated, the four points of the cervical fascia formed by longitudinal and cross division are caught in one continuous suture, the fat pad is approximated with a few interrupted sutures, and the skin incision completely closed.

After a week, subtotal thyroidectomy may be carried out, if the preliminary estimation of the patient has been correct, through a field rendered bloodless by the former operation and therefore in far shorter time than would otherwise be the case. The catgut sutures are soft enough after this interval so that one can separate the layers previously dissected and begin the actual resection of the gland within a few seconds of the start of operation. In final closure, there is almost nothing to ligate except the vessels in the thyroid itself. This "flap cutting" operation will sometimes allow one to do a subtotal thyroidectomy on a patient a week after he could clearly have withstood only single lobectomy and with a better scar than results from lobectomies a week or ten days apart. However, we are gradually coming to the view that the patient on whom lobectomy only is indicated, because of poor general condition, should not have more than one lobectomy performed during that hospital stay since the first operation draws so heavily on his reserve. Two patients within the past year come to mind who simply wilted and died when second lobectomies were performed a

Fig. 2. Full thickness fat flaps mean satisfactory wound closure.

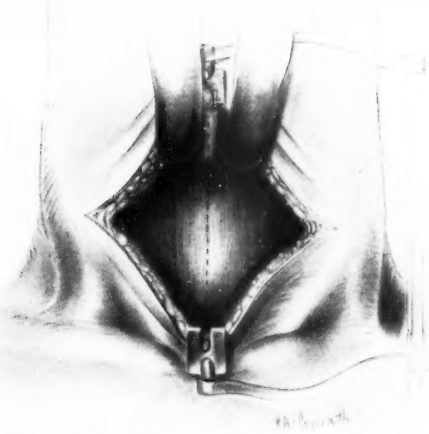

Fig. 3. Position of larynx determines site of mid ribbon cleft.

week after primary lobectomies had been accomplished with practically no upset. The "flap cutting" should be reserved for those who are nearly good enough for subtotal thyroidectomy, but in whom a very large goiter and big, pulsating, superficial veins promise such technical difficulties that, should a slip occur, it would greatly endanger the patient. The "flap cutting" seems to take very little out of the patient since it lasts only a few minutes, the gland itself is not manipulated, and a minimum of inhalation anæsthetic is required, relaxation being unimportant. It becomes difficult to do subtotal operation if as much as 10 days elapse, however, due to the organization of adhesions. One week is the ideal interval. There occurs in our practice a very considerable group of patients past middle age who have not deteriorated to the point that preliminary ligation only is considered, but on whom subtotal thyroidectomy would throw a burden poorly tolerated. Cosmetic considerations are here entirely secondary; it is important that operation be done quickly and that the period of confinement to bed be short. These requirements are ideally met by dividing the operation into two lobectomies done at different periods of hospitalization with an interval of about 3 months intervening. This greatly lessens the risk in working on a person of over, say, 55 years whose cardiovascular-renal situation is made more uncertain by thyrotoxicosis. We are constantly finding new evidence that as little surgery as possible should be done at a time to one past middle life.

Lobectomy is performed in such cases by making the skin incision over the body of the sternomastoid muscle, splitting that muscle through as much of its length as necessary. But little bleeding is encountered and one comes onto the lobe in an unbelievably short time, with excellent exposure. The lobe and part of the isthmus, if desired, are resected in the routine manner, bleeding points are ligated, a Penrose drain is laid over the gland stump with its ends projecting at the upper and lower extremities of the incision, and a single mattress suture of silk is passed through the skin and cervical fascia, drawing them fairly snugly together over the center of the drain. The ultimate scar is astonishingly good and after a year resembles only a fine wrinkle. The natural tendency of the wound edges is to draw together, since the incision is a muscle splitting one. Moreover, only a small portion of the incision extends above the collar of a man, whereas women in the age group in which this operation is usually found desirable are as thoroughly reconciled to wrinkles as they ever will be. We should hesitate very much to follow this technique on a young woman; frankly, no matter how well resigned to such scars the patient may be, her friends form a very different opinion and decide that they will go to a surgeon who makes nice collar incisions that can be hidden by a string of beads. But for results, no other method we know of getting out one lobe in the shortest time and with the least trauma can compare with it. It is beautifully adapted to large glands and to subclavicular lobes, since it

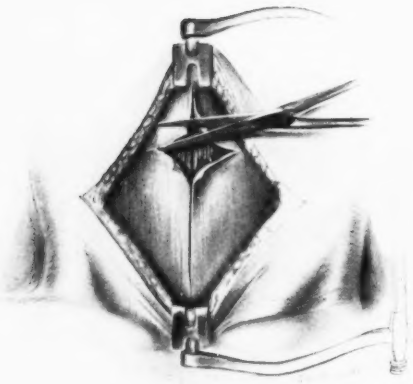

Fig. 4. Adequate exposure without sternohyoid muscle division.

facilitates freeing the upper pole and "skidding" the lobe up into the neck. The opposite side, the site of subsequent operation, is not opened, thus making the second operation quite as easy as the first.

We realize that the subdivision of patients into groups suitable for the various operations so far described has been somewhat indefinite. Only careful individual estimation of each patient permits one to be dogmatic as to what method of approach is preferable. We have indicated somewhat sketchily that (a) the seriously depleted thyrotoxic wreck, with generalized parenchymatous damage, often added to the degeneration of advanced years, is fit only for ligations, followed by a period of restoration, before being considered as a possibility for direct attack on the gland; (b) the patient who lacks a little of being a safe risk for subtotal thyroidectomy, particularly because of anticipated technical difficulties, can have the thyroidectomy itself much simplified by a preliminary flap cutting with an interval of about a week; (c) the patient, especially a man but also a woman of advanced years, who is "too good for ligation" but highly uncertain for subtotal thyroidectomy is more easily and safely handled by single lobectomies through lateral, muscle splitting incisions at different periods of hospitalization about 3 to 6 months apart.

We now come to the patient who is an acceptable risk for subtotal thyroidectomy. The line of skin incision is marked by the pressure of a strand of silkworm gut held between the thumb and index finger of both hands (Fig. 1), the thumbs resting on the clavicles. This puts the incision just at the level at which a string of beads will rest. The mark made by the gut remains as a line of pallor clearly visible for about five minutes against the familiar flush of the thyrotoxic patient's skin. It provides a guide along which the skin incision is made with an accuracy that cannot otherwise be approximated. The incision is carried down through the full thickness of the fat pad, and on the exactness with which this and the succeeding step are carried out depends to a large extent the cosmetic result; the smooth contour of the female neck is due to this pad of subcutaneous fat beneath which lies the platysma. The edge of the upper flap of the incision is lifted by an Allis forceps (Fig. 2) which is carefully placed to grasp its full thickness, that the entire fat pad may be dissected away, with the skin, from the platysma. The lower flap is similarly dissected but only for 2 or 3 centimeters from the line of incision. By leaving the platysma attached to the deep layers, we avoid cross division of the large veins lying beneath it. The upper and lower flaps are now lifted and automatic retractors separate them vertically, thus exposing the deeper layers covered by platysma. The next step is the exact location of the larynx; this is done by palpation of it between the index and middle fingers of the operator's left hand (Fig. 3), the tips of the fingers pointing toward the patient's feet. From a point equidistant between them the longitudinal incision of platysma, cervical fascia and ribbon muscles is carried out; an incision made thus will properly separate the ribbon muscles, which may have been deflected to one side or the other by unequal enlargement of the two lobes. With the longitudinal incision guided by preliminary palpation of the larynx one follows the anatomical midline. If the goiter is large or the neck muscles particularly powerful, we obtain more room by a high cross division of the cervical fascia, rather than by cross dividing the ribbon muscles. This is done by slipping the scissors transversely between the fascia and the muscle (Fig. 4), at a point slightly below the apex of the upper pole, then cutting the fascia for a distance of about 3 centimeters from the midline. This may be done on either or both sides. Retraction of the muscles, once this cross division of the fascia has been made, is easy and gives adequate exposure in all but enormous goiters. Small hæmostats are left on the four points of fascia thus formed for approximation at closure.

Narrow retractors are inserted into the incision on the side to be approached first, one opposite

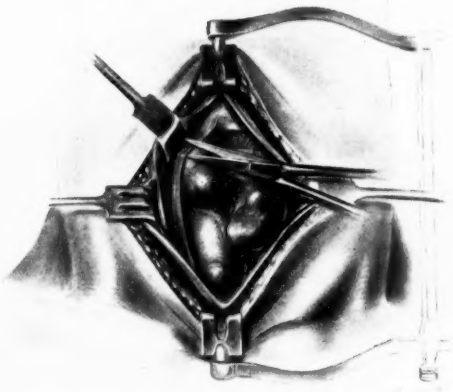

Fig. 5. Upper pole uncovered by sacrifice of sternothyroid muscle.

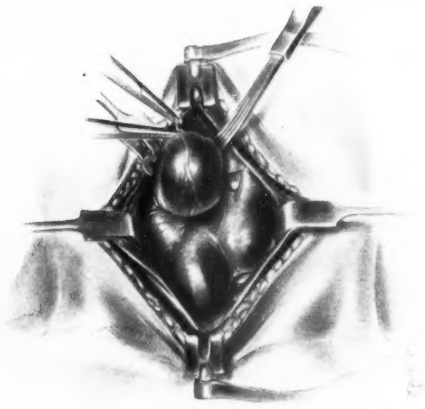

Fig. 6. Recurrence obviated by complete removal of upper pole.

the main body of the lobe, the other opposite the upper pole. Retraction is maintained not only laterally but also upward "toward the ceiling." The sternothyroid muscle is seen crossing the lobe diagonally and is cross divided and sacrificed entirely (Fig. 5), the retractors being replaced more deeply to include it as well as the fine film of cervical fascia which invests the anterior and lateral surfaces of the lobe and is readily separated from the true capsule of the gland. This proper "cleaning" of the gland and upper pole free of the minor muscle and fascial elements, often stuck to the capsule because of perithyroiditis, is most important in facilitating later delivery of the upper pole and the lobe itself without dangerous traction on them. The success of one's handling of the thyroid is throughout dependent to a large extent on one's appreciation of tissue planes and lines of cleavage; this is most strikingly true in dealing with large goiters and substernal or retrotracheal growths, and can readily be appreciated in seeing how a dexterous surgeon who is familiar with the problem will make such a gland seem to "pop up" into a position where it can be conveniently handled.

The retractors in the hands of the second assistant are now holding away the tissues investing the lateral aspect of the lobe, while we attack the upper pole. As was done in ligation, the pole is grasped, as high as possible, with a hæmostat and gently lifted up out of the neck toward the operator. At the same time a Kocher ligature carrier is inserted into the groove between the pole and the larynx and passed laterally (Fig. 6), and slightly superiorly, maintaining pressure against the pole with the Kocher and lifting the pole out of the neck until the point of the instrument can be felt and seen to have passed completely behind the pole. If any tissues remain covering the point of the Kocher, they may be carefully separated from the pole and pushed laterally by an assistant, thus freeing the Kocher entirely. It is highly important in order to avoid injury to the larynx that the larynx be not used as a fulcrum for depression of the handle of the Kocher; the pressure on the instrument need be only light, if one is in the proper layer immediately within the fascia surrounding the pole, and must be applied only in a lateral direction. During this maneuver, the index finger of the left hand may rest lightly against the lateral wall of the pole and toward its posterior surface; the difference between thyroid tissue and surrounding structures should be familiar enough that any tendency of the Kocher to penetrate the pole, thus leaving some of it, or to go too deeply can be instantly detected.

With the pole freed and lifted toward the operator, a downward pull is now maintained by the hæmostat first placed on it while the first assistant places hæmostats, their points directed transversely and slightly upward, on the lateral, anterior, and medial surfaces of the pole and completely divides it below them; one or two more hæmostats control the back bleeding. It is seen that there is no thyroid tissue remaining above an intact blood supply when the pole is dealt with in this way. This is, in our opinion, highly

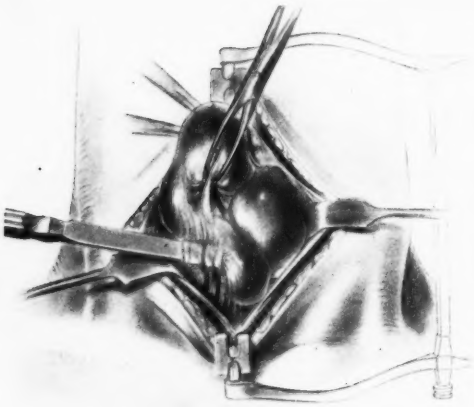

Fig. 7. Delivery of lower pole by traction on accessory veins, etc.

important, for the majority of recurrences that come to us from other surgeons have their recurrences in the upper poles which clearly, as seen at operation, have never been exposed before. In no other way than by fully exposing and bringing up the tissue can really high poles be removed.

The delivery of the body of the lobe is next carried out. It is grasped toward its lateral surface by a fine toothed clamp and rotated medially and out of the neck. While this tension is maintained a flat instrument, such as the Kocher ligature carrier or the closed blades of the scissors, is introduced into the cleavage plane between the thin investing fascia and the true gland capsule and as the communicating veins are encountered at the lateral-inferior border of the lobe they are lifted (Fig. 7) on the point of the dissecting instrument and divided between hæmostats; their medial portions are then used to help maintain the rotating and lifting tension on the lobe. This method of blunt and sharp dissection against constant tension is carried around the lower pole and then toward the midline until the entire lobe can be brought up completely free of all attachments save those on its posterior surface and the opposite lobe. During this step, the point of application of traction on the lobe is shifted as the dissection proceeds; likewise the retractor in the hand of the second assistant is slid along so that it remains opposite the advancing point of dissection and provides the maximum room for the operator. With a retrotracheal growth or one that is largely subclavicular, tension on the gland is best maintained by a sharp toothed or "cat's-paw" retractor which is shifted to take a fresh grip as the lobe is rolled out of its bed. Strong traction on the gland is at no time safe or necessary. This method depends on the fact that the gland will literally roll out of its bed if the investing layers are dissected off in the proper plane against gentle tension. It will be noted that no mention has been made of manipulation or delivery of the gland by the operator's fingers. It is our custom to keep our fingers out of the neck except for the purpose of occasional palpation, never for manipulation of structures. Such handling is a fruitful source of injury to the recurrent nerve. The one occasion on which fingers are more useful than dangerous is in the delivery of a subclavicular lobe; once the upper pole has been delivered, the lateral veins divided and the proper tissue plane entered laterally, the operator's index finger may be introduced along this plane beneath the clavicle and used to strip off the tissues investing the capsule at the inferior margin of the lobe. Here again, however, pressure is not exerted toward the gland but away from it, the delivery of the lobe being accomplished by upward rotation with a sharp toothed retractor as the investing tissues are stripped off the capsule.

Once the lobe has been delivered, a row of hæmostats is placed in position on the capsule from the point at which the posterior border of the upper pole joins the lobe around the lateral and inferior surfaces of the lobe to the midline (Fig. 8). These mark the plane of resection and, in placing them, the operator determines how much of the lobe shall be left in view of the character of the gland and the patient's toxicity and age. Behind this line no cutting or manipulation is to be done; the usual sites of the majority of the parathyroids and of the recurrent nerve are protected. After the lobe is marked for resection, a fresh towel is placed across this side of the field, the second assistant moves to the opposite side of the table, and the opposite lobe is attacked in the same way by cross cutting the sternothyroid and stripping it laterally, delivering and dividing the upper pole, freeing the lateral and inferior margins of the lobe by blunt and sharp dissection against tension, delivering the lobe and applying the row of clamps marking the plane of resection.

We are now performing the actual amputation of the lobes with a high frequency "knife" of the type being tested by the American College of Surgeons (Fig. 8). It is at its best on the

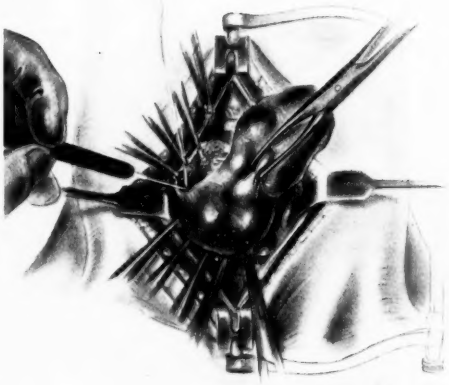

Fig. 8. Resection plane identified before endotherm amputation.

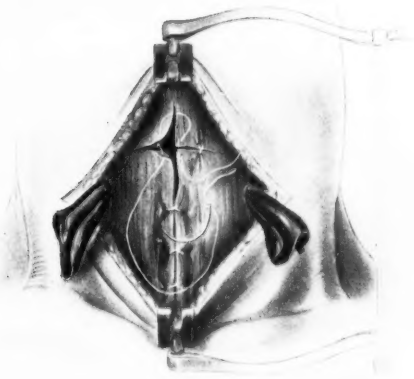

Fig. 9. Prevent skin-swallow "tug" by avoiding midline drains.

diffusely hyperplastic glands in which ordinarily there is much capillary oozing. The instrument does away with this, so that fewer clamps are placed in the field; moreover, this effect of sealing the surface of the stump should, and probably does, somewhat decrease postoperative toxicity. Following amputation, the current is changed from "cutting" to "coagulating" and the bits of tissue held by hæmostats, except those on the upper pole, are touched with the instrument and the clamps removed. A few larger vessels will sometimes have to be caught again, in which case they are tied. We have occasionally done cases in which no ligatures whatever were necessary other than the transfixing and ligation of the upper poles. Unquestionably a tremendous saving in time of closure results in all cases and, as less catgut is left in the neck there is a saving in catgut expense and less tendency to serum collection. The use of the high frequency knife will undoubtedly result in our doing fewer flap cutting operations in the future, since the time consuming ligation of bleeding points is so largely obviated. After amputation of the stump, the upper poles are transfixed with a suture and tied, all ligation necessary after coagulation is carried out and, if there is any tendency of the stump to be "wet," a running suture of catgut is whipped around the edge of the stump and brought across under tension and sutured to the stump of the upper pole, to produce pressure on the gland bed. The inhalation anæsthetic is taken away and the patient is roused sufficiently to strain or cough and the stump again inspected for bleeding. It is preferable to have an overlooked vessel start oozing at this point rather than after the patient has been put to bed and first begins to talk and swallow.

Closure and drainage of the neck remain. We drain after practically all goiter operations. A narrow retractor is placed in the cavity and its handle elevated and pushed toward the midline so that the tip of the retractor presses outward and upward against the muscles and cervical fascia at a point just medial to the end of the skin incision. A small longitudinal incision through these layers is made with the high frequency knife sufficient to free the tip of the retractor to which a hæmostat is fastened and pulled through into the cavity by reversing the pull on the retractor. A Penrose drain, varying in length according to the amount of dead space to be filled, is placed between the blades of the hæmostat which are then locked and the instrument is withdrawn, bringing the tip of the drain with it. The portion of drain within the neck is carefully packed into the cavity on that side. Another drain is introduced into the opposite cavity in a similar fashion. They do not cross the trachea, but come out their respective sides (Fig. 9). We are now ready for closure. The patient's head is raised, flexing the neck, and the four hæmostats marking the four corners of the cervical fascia (if the fascia was cross cut) are brought together and transfixed by a suture. An additional suture may be placed laterally on each side if the cross division has been over 2 centimeters long. This suture is tied and con-

Fig. 10. Adequate fat plastic means thin, loose skin scar.

tinued downward, uniting the cervical fascia in the midline throughout the length of the longitudinal incision (Fig. 9). We have thus avoided crossing the trachea with drains and bringing them through the midline incision in the fascia. This is of great value in avoiding fixation of the incision to the trachea, especially in the case of very large goiters the removal of which leaves much dead space. The automatic retractors are now removed from the upper and lower flaps and a careful search for bleeding under the flaps is made after we have removed the tension on them. Three to five interrupted sutures are placed in the fat (Fig. 10); if this step is accurately done the skin edges will be found nicely approximated and suture of the skin is necessary only to prevent displacement of the levels during the few hours required for sealing off the skin edges. The sutures in the fat pad take the tension, moreover, off the skin sutures. We use No. 0000 Chinese silk, swedged on to No. 12 non-cutting needles, for the skin, starting a continuous suture from the midline laterally on each side to the point at which the drain protrudes at the extreme angle (Fig. 10) of the incision. Skin sutures are removed in 24 hours; drains are removed half way at 24 hours and entirely at 48 hours unless the goiter has been very large, in which case they remain longer.

We have emphasized the importance to the final cosmetic result of (1) accurate dissection of the entire fat pad along with the skin flaps; (2) avoidance of cross cutting the sternohyoid and omohyoid, substituting cross division of the fascia instead; (3) complete closure of the longitudinal incision in the cervical fascia; and (4) accurate suture of the fat pad in closure. In those cases which occur sometimes, though rarely, in which we have either not closed the neck at operation or have had to reopen it later for any purpose, we take advantage of the first, third, and fourth of the points mentioned in doing *secondary closure*. There is always a certain amount of infection in such a wound and sufficient time must be allowed for this to have fairly well cleared up, as well as for the patient to have recovered entirely from the situation that precipitated the emergency resulting in the incision's having been left unsutured or reopened. This period is usually from 10 days to 2 weeks. Under very light nitrous oxide inhalation the fat pad is stripped back from whatever position in which it has become adherent in both upper and lower flaps. One or two sutures draw the cervical fascia together over the larynx and upper trachea. The entire thickness of the flaps is then strongly everted above and below, brought together, and secured by several interrupted sutures passing only through the fat. A single, narrow flat strip of rubber lies transversely beneath the fat and protrudes at either angle of the incision. No sutures are placed in the skin, since approximation of the fat in marked eversion of the edges of the flaps will lead to gradual approach and union of the skin edges in spite of the inversion resulting from the previous inflammation and oedema; the drain is removed in 2 or 3 days. We have had the best results from dealing with secondary closures in this way.

ARTHRODESIS OF HIP[1]

With Special Reference to a Method of Securing Ankylosis in Massive Destruction of the Joint

LEROY C. ABBOTT, M.D., F.A.C.S., San Francisco, California
AND
FREDERICK J. FISCHER, M.D., Detroit, Michigan

THE purpose of this paper is to describe a method of performing arthrodesis of the hip in children in whom tuberculous or pyogenic infection has caused massive destruction of the joint. In the typical case for which this method is especially suitable, the head and neck of the femur have been completely destroyed and the acetabulum has been markedly eroded. The upper end of the femur represented by the great trochanter may lie near the acetabulum or may be displaced upward on the wing of the ilium. In either position it is commonly fixed by scar tissue, cartilage, or bone (Figs. 1, 4, and 7).

Important clinical findings in this group of patients are limp, a limited range of motion which is often painful, deformity, and instability of the joint. The indications for treatment therefore are (1) correction of the deformity and (2) the production of a painless and stable joint by arthrodesis.

In our experience, correction of deformity has readily been secured but the production of bony ankylosis has been difficult to accomplish. Frequent failure to obtain bony fusion by any of the commonly accepted methods of arthrodesis has led to the development of a procedure which has been highly successful in the treatment of this rather difficult group of patients. This procedure is carried out in several stages: (1) correction of deformity; (2) arthrodesis of the hip in wide abduction; and (3) reduction of the widely abducted position by subtrochanteric osteotomy.

CORRECTION OF DEFORMITY

In the majority of our patients, the disease was quiescent as far as could be determined by clinical and roentgenological examinations. Deformities of flexion and adduction, together with shortening, were of common occurrence. In the patient with a moderate degree of deformity, correction was generally secured by gradual stretching of the contracted flexor and adductor group of muscles with adhesive traction. In the more severe deformities, correction was obtained by freeing the great trochanter from the wing of the ilium and applying heavy traction to a steel pin which had been drilled through the lower end of the diaphysis of the femur. With either type of traction the affected extremity was gradually brought to a position of wide abduction. Traction plus wide abduction brings the great trochanter adjacent to the acetabulum so that these two structures can more readily be placed in apposition at the time of arthrodesis.

ARTHRODESIS OF THE HIP IN WIDE ABDUCTION

It has been our experience that the usual method of approximating the denuded upper surfaces of the great trochanter and acetabulum frequently fails to secure bony ankylosis. Fibrous union and recurrence of deformity is common. We believe that fusion occurs infrequently because of the small areas of bone which are apposed to one another. Furthermore, we have often failed to secure bony ankylosis by any of the so-called extra-articular methods. We attribute our failures to difficult technical problems involved in dealing with this particular type of case, i.e., massive destruction of the head of the femur, and to incomplete fixation. Neither have we had any great success in those cases in which a combination of intra-articular and extra-articular arthrodeses has been employed.

In the method which we are now using, we appose extensive bone surfaces under complete fixation and pressure. In more detail, the operation is conducted as follows: Through a Smith-Petersen incision the acetabulum and upper shaft of the femur are exposed. Scar tissue and cortical bone is then removed from the upper and inner surfaces of the acetabulum and the superior, anterior, lateral, and posterior surfaces of the great trochanter and upper shaft of the femur until fresh cancellous bone is exposed. The extremity is now placed in wide abduction thus forcing the tip of the great trochanter well within the acetabular cavity. This permits the superior and lateral surfaces of the great trochanter and the upper lateral aspect of the shaft of the femur to lie in intimate contact with the superior and internal surfaces of the acetabulum. No attempt is made at this time to secure the correct position of the

[1]From the Shriners' Hospital for Crippled Children and the Department of Surgery of Washington University.

Fig. 1. Destruction of the head and neck of the femur and acetabulum. Note marked adduction deformity. (Case 1.)

hip for weight bearing. The single aim of the operation is to obtain bony ankylosis.

The degree of abduction varies with the individual case. In some, 30 degrees may be sufficient; in others, 70 to 90 degrees may be required in order to secure accurate fitting and wide apposition of the bony surfaces (Figs. 2 and 5). We feel that the chances of a bony union are much increased by securing the widest contact of bony surfaces under complete fixation and firm pressure. These principles of treatment are fulfilled by wide abduction of the extremity.

The wound is now closed and fixation is secured by the application of a double plaster-of-Paris spica extending to the toes on affected side and to just above the knee on unaffected side.

The next step is to determine by accurate measurements the exact position of the hip which will produce the best possible function of the extremity. The degree of flexion and abduction is estimated for the individual case largely on the amount of shortening present. It is well to remember, however, as shown by A. O. Adams in his recent article,[1] that abduction of the hip beyond a certain number of degrees is not desirable because of the marked tilting of the pelvis and the awkward gait which it produces. In certain cases in which ankylosis is secured by a minimum amount of abduction, no change in position may be necessary. On the other hand, patients with ankylosis in extreme abduction require correction of the faulty position by osteotomy of the femur.

[1] Surg., Gynec. & Obst., 1931, lii, 261–265.

CORRECTION OF THE POSITION OF WIDE ABDUCTION BY OSTEOTOMY

Reduction of the degree of abduction is secured by a transverse subtrochanteric osteotomy followed by gradual bending of the callus. This simple method was described in a recent article.[2] Its advantages over other types of osteotomy lie in its simplicity of execution and the fact that it reduces to a minimum the danger of displacement of the fragments.

In more detail our procedure in these widely abducted hips is to bivalve the plaster spica which has been used for fixation following the arthrodesis. This spica is retained for immobilization following osteotomy.

In the operating room after the usual skin preparation, the anterior limb of the Smith-Petersen incision which was used for the operation of arthrodesis is incised and the tensor fascia femoris is separated from the sartorius. The rectus femoris is then retracted inward thus exposing the periosteum of the femur between this muscle and the vastus lateralis. At this stage of the operation it may be necessary to ligate branches of the lateral circumflex artery. The periosteum is then incised and a transverse osteotomy performed just below the level of the lesser trochanter. This brings the site of osteotomy as close to the ankylosed joint as practical. The wound is then closed and the bivalved plaster-of-Paris spica is reapplied and held in place with adhesive or a few turns of plaster-of-Paris bandage. No attempt is made at this time to change the position of the extremity.

Two weeks after this operation the hip is examined and roentgenograms are taken. If the roentgenogram shows beginning callus formation and the clinical examination indicates some fixation of the fragments, we remove the spica and apply adhesive tape to both lower extremities. A Thomas splint is used to support the side operated upon. With the affected extremity held in its initial position of abduction and the normal extremity in line with the trunk, a weight with a pulley is attached to the ends of the adhesive tape traction. Traction on the unaffected side controls the position of the pelvis. Each day reduction of the degree of abduction is affected by changing the axis of traction until the position determined upon before operation is obtained. Flexion of the desired amount, usually 20 to 2

[2] Abbott, L. C., and Jostes, F. A. Surg., Gynec. & Obst., 1926, xlii, 27 282.

Fig. 2. Bony ankylosis after arthrodesis in wide abduction. (Case 1.)

Fig. 3. Correction of widely abducted position by subtrochanteric osteotomy and bending of the callus. (Case 1.)

degrees, is then secured by elevating the lower end of the Thomas splint.

The time required for bending of the callus is usually 10 days. Having obtained the desired position, the patient remains with the traction in place until the callus at the site of osteotomy is consolidated. During this interval massage and motion of the knee are instituted and the position of the extremity is frequently checked up by measurements and roentgenograms. It has also been our practice 4 or 5 weeks after osteotomy, to remove the Thomas splint, bring the legs parallel, and carefully check the position by measurements.

A great advantage of the method, aside from those already mentioned, is that it permits the correction of the abduction and the determination of the exact position desired by frequent observation and measurements. An osteotomy with a complete correction at the time of operation followed by fixation in plaster does not possess this important advantage. This procedure has proved so satisfactory that we have discarded the older methods of osteotomy except in the simpler cases requiring a minimum amount of correction.

RESULTS

Eleven patients with advanced destruction of the hip have been treated by this method. The youngest patient was 7 years of age, the oldest 15. The average age was 11.2 years. In 9 cases the disease was quiescent while in 2, the activity of the destructive process was evident because of the presence of discharging sinuses. The results secured in these two infected cases are of interest. In the first case incomplete ankylosis with one small discharging sinus remains after a period of 11 months. In the second case clinical ankylosis with healed sinuses is present after 14 months. Though difficult to form judgment from the experience gained with but 2 cases, it would seem that in the presence of sinuses, ankylosis is likely to be delayed or may not occur at all.

In the 9 quiescent cases operated upon, bony ankylosis has occurred in 7 (Figs. 2, 6, and 9). In 1 case incomplete ankylosis is present after 1 year and must be classed as a failure. In a second case, beginning bony ankylosis is shown in the roentgenogram 4 months after operation. It is too early, however, to include this patient in the end-results. In the 7 remaining cases, the average time in which the X-ray gave evidence of beginning ankylosis was 4.2 months. The average length of time elapsing between the operation of arthrodesis and the correction of wide abduction by osteotomy was 5.9 months.

The results have been highly satisfactory in all cases treated by this method except those who have had discharging sinuses. The patients are able to walk and sit with comfort and none of them has pain. We believe that these satisfactory results are due to bony ankylosis secured with the joint held in the best possible position for future function. We wish to emphasize the importance of careful check-up measurements in order to be certain that the position for maximum function is secured.

CASE REPORTS

Case 1. M. W., aged 11 years, was admitted November 13, 1925, complaining of stiffness and deformity of the left hip. In 1917, at the age of 3 years, the patient fell from a

Fig. 4. Extensive destruction of the head and neck of the femur with marked erosion of the acetabulum. There was marked flexion and adduction deformity. (Case 3.)

second story window injuring the left hip. One week later she began complaining of pain in the hip and was removed to a hospital where X-rays were taken, and treatment was instituted by means of traction and later the application of plaster.

At the time of admission to the Shriners' Hospital there was no pain or tenderness in the hip but the patient complained of limp, shortening, stiffness, and deformity.

The general physical examination was essentially negative. The left hip was held in a position of 30 degrees' flexion and 20 degrees' adduction with a few degrees of motion in flexion and extension. There was 3 inches of true shortening of the left lower extremity, most of which was confined to the femur. The foot was held in marked equinus and the patient walked with a decided limp. There was also a marked compensatory lordosis in the lumbar spine.

The roentgen-ray examination, October 9, 1925, showed an old destructive process of the left hip joint with complete disappearance of the head and neck of the femur and outline of the acetabulum. There was an upward dislocation of the upper extremity of the femur. The diagnosis was old tuberculosis of the left hip joint with pathological dislocation (Fig. 1).

Operation. On November 16, 1925, a section of the adductor muscles was done and a Steinmann pin was inserted in the lower end of the left femur. Traction was applied and slowly increased to 50 pounds. The position of the extremity was gradually changed to one of wide abduction.

On December 10, 1925, the deformity was completely corrected. An arthrodesis of the hip was performed in a position of wide abduction. A plaster-of-Paris spica was applied. The patient's postoperative convalescence was entirely uneventful and she was discharged in a solid hip spica on February 22, 1926.

On July 23, 1926, the patient was readmitted to the hospital. Clinically the hip was solidly ankylosed. The roentgen-ray examination, August 7, 1926, showed solid ankylosis of the hip joint (Fig. 2).

Operation. On September 23, 1926, a subtrochanteric osteotomy of the left femur was done. This was followed by a gradual bending of the leg until a position of 25 degrees' flexion and 2 degrees' abduction was secured. A double spica was applied and the patient was discharged.

A check-up roentgen-ray examination, January 12, 1927, showed abundant callus formation with good alignment of the fragments. A walking plaster was applied and the patient was discharged (Fig. 3).

Subsequently the patient gained 1½ inches length by lengthening of the tibia and fibula.

On March 6, 1929, examination revealed the hip to be solidly ankylosed in 25 degrees' flexion and 2 degrees' abduction. There remained a true shortening of 1½ inches and an apparent shortening of 1¼ inches of the left lower extremity.

The patient assumed a fair sitting position and was able to climb stairs one foot at a time, and complained of no pain in either the hip or back. The gait was markedly improved.

Case 2. W. C., aged 13 years, was admitted to the hospital October 13, 1925, complaining of deformity of the left lower extremity. In 1917, at the age of 4 years the patient became acutely ill, the onset being marked by pain in both lower extremities. The acute symptoms continued for 1 month and at this time the patient showed evidence of cerebral involvement, being unconscious most of the time. At the end of the illness the left hip became markedly swollen, painful, and tender. The patient was removed to a hospital where a plaster spica was applied. This treatment was continued for a period of 7 months at the end of which time the cast was removed. There was no subsequent treatment.

At the time of admission to the Shriners' Hospital the patient walked with a considerable limp. The foot was held in equinus to compensate for the shortening which was present.

The physical examination disclosed that the patient was a very markedly undersized and undernourished boy of 13 years. The general physical examination otherwise was essentially negative. The left hip was fixed in a position of 70 degrees' flexion and 10 degrees' adduction. There was 20 degrees' range of motion in flexion and extension. The trochanter was high above Nélaton's line. There was no tenderness or sensitiveness about the joint. The left leg was 2 inches short and the patient walked with a very awkward gait.

Roentgen-ray examination revealed complete destruction of the head and most of the neck of the femur with an upward dislocation of the upper extremity of the femur. The diagnosis was old tuberculosis of the hip joint with pathological dislocation.

Operation. On October 19, 1925, a section of the left adductor muscles and a fasciotomy of the left hip flexors followed by manipulation of the left hip was done.

Operation. On November 23, 1925, an intra-articular arthrodesis of the left hip was done. The postoperative convalescence was quite uneventful and the patient was discharged in a plaster spica.

The check-up roentgen-ray examination, January 26, 1927, showed partial ankylosis of the hip joint. Clinically the hip appeared to be drifting into a position of deformity.

On March 8, 1927, the patient was readmitted to the hospital. Clinical and roentgen-ray examination showed the left hip to be unstable and in a position of adduction.

Operation. April 4, 1927, the stump of the femur was freed from the acetabulum and a Steinmann pin was placed in the lower end of the femur. This was followed by the application of traction and a gradual correction of the deformity was obtained.

Operation. May 2, 1927, an arthrodesis of the left hip was done after the method described and was maintained

Fig. 5. Roentgenogram taken 3½ months after arthrodesis in wide abduction. (Case 3.)

Fig. 6. Roentgenogram showing solid bony fusion 14 months after arthrodesis. (Case 3.)

in a plaster spica. Immobilization was continued until April 6, 1928, at which time the hip appeared to be solidly ankylosed.

December 12, 1928, measurements showed the hip to be in a position of 19 degrees' abduction and 30 degrees' flexion. There was 3 inches of true shortening and 1¼ inches' apparent shortening. Clinical and roentgen-ray examination showed the hip to be solidly ankylosed.

The patient walked very well with a ¾ inch lift under the left shoe. He assumed a good sitting position and was able to climb stairs fairly well. The patient complained of no discomfort in the back and was well satisfied with the result.

CASE 3. V. W., aged 12 years, was admitted September 6, 1927, complaining of a deformity of the left hip and shortening of the left lower extremity. In 1919 at the age of 4½ years, the patient developed a limp at intervals of 3 or 4 months over a period of 1 year. At the end of this time he developed a rise in temperature and complained of severe pain in the left hip associated with night cries. Walking finally became impossible and a plaster spica was applied. After 6 months this was removed and a brace applied which was worn for 1 year. Three years previous to admission, an abscess of the left hip developed, which was incised and drained. At the time of admission there was no pain about the hip but the patient walked with an extreme limp.

The general physical examination was essentially negative. The left hip was fixed in a position of extreme flexion and adduction with only a few degrees' range of motion in flexion and extension present. All sinuses were healed. There was no tenderness or sensitiveness about the joint. Measurements showed 3½ inches' true shortening of the left lower extremity, most of which was confined to the femur. The patient walked on the ball of the foot and toes with a very awkward gait and decided limp. There was also a marked compensatory lordosis of the lumbar spine.

The roentgen-ray examination revealed an extensive destructive process involving the head and neck of the femur and the acetabulum. There was complete absence of the head of the femur, almost complete absence of the neck, and an upward erosion of the acetabulum. The diagnosis was old tuberculosis of the left hip joint (Fig. 4).

Operation. On September 12, 1927, a tenotomy of the left hip flexors and adductors and an insertion of a Steinmann pin in the lower end of the femur was done. Traction was applied and the deformity was gradually corrected.

Operation. On November 18, 1927, an arthrodesis of the hip was done, the hip being placed in a position of wide abduction and maintained in a plaster spica.

The roentgen-ray examination, March 3, 1928, showed bony proliferation around the joint with evidence of early ankylosis (Fig. 5).

Operation. On April 2, 1928, a subtrochanteric osteotomy of the left femur was done followed by a gradual bending of the leg into a position of 15 degrees' abduction and 22 degrees' flexion.

On August 9, 1928, the patient was discharged from the hospital, walking with crutches and a ¾ inch lift on the sole of the left shoe.

February 6, 1929. Examination at this time revealed the hip to be solidly ankylosed clinically and by X-ray examination in a position of 15 degrees' abduction and 22 degrees' flexion (Fig. 6). There was 3 inches of true and ½ inch of apparent shortening of the left lower extremity. It required a ¾ inch block under the left shoe to make the legs appear equal in length. The patient walked with only a very slight limp. He was able to climb stairs well and assumed a good sitting position. There was no pain or discomfort in the back. The gait was improved and the lumbar lordosis was decreased.

CASE 4. L. K., aged 7 years, was admitted to the hospital March 1, 1927, complaining of a deformity of the right hip and a limp. In 1922 at the age of 2 years, the patient developed an attack of pneumonia. Several days following the onset he began complaining of pain in the right hip. There was no apparent swelling of the hip but it gradually became drawn up into a position of flexion and was exceedingly painful on manipulation. The patient was unable to walk for a period of 1 year and then with a very pronounced limp.

Fig. 7. Roentgenogram showing destruction of the right hip joint with extreme adduction deformity. (Case 5.)

Two years previous to admission, patient fell injuring the right hip. Two days later he complained of severe pain and inability to walk. He was confined to bed and a splint was applied to the leg. One week previous to admission the splint was removed and the patient began walking. The limp, however, was more pronounced and the patient complained of pain in the hip joint at intervals.

The patient was a fairly well developed and nourished, rather pale looking boy of 7 years. Otherwise the general physical examination was essentially negative. The patient walked with an awkward lurching gait somewhat like that seen in congenital dislocation of the hip. Motion in the hip joint was quite free in flexion, extension, and rotation but limited in abduction. The great trochanter was displaced above Nélaton's line and there was 2 inches of true shortening most of which was confined to the femur.

The roentgen-ray examination revealed a complete destruction of the head of the femur and almost complete destruction of the neck. The acetabulum showed an old destructive process with upward erosion on to the wing of the ilium.

Operation. On March 3, 1927, an arthrodesis of the right hip was done the hip being placed in a position of wide abduction and maintained in a plaster spica. The postoperative convalescence was uneventful.

On August 15, 1927, the hip appeared to be solidly ankylosed clinically and by roentgen-ray examination. Accordingly a subtrochanteric osteotomy of the right femur was done followed by gradual bending of the leg into a position of 12 degrees' abduction and 22 degrees' flexion. During the bending process the distal fragment became displaced medially along the shaft of the proximal fragment. The fragments, however, united solidly.

On March 6, 1928, the patient was discharged wearing a ¼ inch lift on the sole of the right shoe to compensate for the remaining apparent shortening.

March 13, 1929. The patient last presented himself for examination. The hip was found to be solidly ankylosed in a position of 12 degrees' abduction, 22 degrees' flexion, and slight external rotation. There remained 2 inches of true shortening of the right lower extremity with ¾ inch apparent shortening. The patient walked with a very slight limp, assumed a good sitting position, and was able to climb stairs well. The patient has been leading a very active life with no discomfort in either hip or back.

CASE 5. N. C., aged 11 years, was admitted June 22, 1928, complaining of stiff hip on the right. In 1920 at the age of 2½ years, the patient fell injuring the right hip. No subsequent disability was noticed until 6 months later when he developed a limp. One year later the patient became acutely ill with an associated tender and red swelling of the right hip. This soon ruptured spontaneously and the patient continued to have draining sinuses until 1 year previous to his admission.

At the time of admission to the Shriners' Hospital the hip was not painful. The patient walked with an awkward limp on the ball and toes of the right foot.

The patient was a fairly well developed and nourished boy of 11 years. The general physical examination was essentially negative. There was a marked flexion and adduction deformity of the right hip. The hip was not tender or painful and a few degrees' range of motion was present. There was 1 inch of true shortening of the right lower extremity. Scars of previous sinuses were present above the greater trochanter and in the groin.

The roentgen-ray examination revealed an old destructive process of the right hip joint with complete absence of the head and greater part of the neck of the femur. There was also complete loss of the upper outline of the acetabulum with upward erosion on the ilium (Fig. 7).

Operation. On June 28, 1928, a section of the adductor muscles and insertion of a Steinmann pin in the lower end of the femur was done. Traction was applied and the deformity corrected.

Operation. On July 23, 1928, an arthrodesis of the right hip was done after the method described.

The roentgen-ray examination October 24, 1928, showed a fair degree of ankylosis to be present (Fig. 8). The check-up measurements at that time showed the hip to be in a position of 25 degrees' abduction and no flexion. There was 2 inches of true shortening of the right lower extremity.

Operation. On January 24, 1929, a subtrochanteric osteotomy of the right femur was done followed by gradual bending of the leg into a position of 13 degrees' abduction and 22 degrees' flexion.

The roentgen-ray examination, March 23, 1929 (Fig. 9), showed the fragment in good position with abundant callus formation. The hip joint appeared to be solidly ankylosed. Clinically the hip joint was solid. A walking spica was applied with a ¾ inch lift under the right shoe to compensate for the remaining apparent shortening and the patient was gradually permitted to bear weight.

December 18, 1929. The out patient examination showed the sinuses to be healed. The hip was solidly ankylosed in a position of 11 degrees' abduction and 25 degrees' flexion. One inch of apparent shortening remained.

CASE 6. M. R., aged 15 years, was admitted March 5, 1929, complaining of deformity of the left hip. In 1923 at the age of 9 years, the patient began complaining of pain in the left hip and developed a limp. She was treated by means of traction and finally an arthrodesis of the hip was done. Previous to the operation, the patient developed numerous sinuses about the hip. Following operation the wound did not heal completely until after a period of a year. Since that time the patient has walked with a severe limp and during the last year a curvature of the spine has

Fig. 8. Roentgenogram taken 3 months after arthrodesis. Note beginning ankylosis. (Case 5.)

Fig. 9. Bony ankylosis of the joint and correction of wide abduction by subtrochanteric osteotomy and bending of the callus. (Case 5.)

been noticed. After moderate exertion the patient complained of generalized back pain.

The general physical examination revealed a well developed and nourished girl of 15 years with a mitral heart lesion, but she was otherwise essentially negative. The patient walked with a very awkward gait with a 3 inch lift under the left shoe. The hip was in a position of 10 degrees' adduction and 25 degrees' flexion with slight motion in flexion and extension present. There was 2 inches of true shortening of the femur.

Roentgen-ray examination revealed almost complete destruction of the hip joint with no evidence of bony ankylosis.

Operation. On April 8, 1929, an intra-articular arthrodesis, employing the above described method was done. The clinical and roentgen-ray examinations, October 2, 1929, showed the hip to be solidly ankylosed.

Operation. On October 21, 1929, a subtrochanteric osteotomy was done followed by a gradual bending of the leg into a position of 6 degrees' abduction and 25 degrees' flexion. Two months later the patient was discharged.

March 18, 1930. The patient was readmitted for a femur lengthening. The roentgen-ray and clinical examinations showed the hip to be solidly ankylosed in a position of 6 degrees' abduction and 25 degrees' flexion.

CASE 7. V. B., aged 9 years, was admitted October 18, 1929, complaining of a limp and shortening of the left leg.

In 1920, at the age of 2½ months, the patient developed an acute tender swelling about the left hip and thigh, associated with night cries and an elevation of temperature. Six weeks later an abscess ruptured on the inside of the thigh. This was followed by the appearance of several other abscesses which drained for the next 12 months. There had been no draining since and no recurrence of the acute symptoms. The patient began walking at the age of 1½ years and has always had a limp.

The patient was an otherwise healthy boy of 9 who walked with an awkward limp resembling that seen in congenital dislocation of the hip. Further examination revealed a positive Trendelenburg sign and the trochanter was elevated above Nélaton's line. The motion was free in all directions with the exception of abduction which was markedly limited. There was considerable telescoping of the hip and 1½ inches' true shortening of the left lower extremity.

The roentgen-ray examination, October 18, 1929, revealed the left hip to have been the site of an old destructive process with complete destruction of the head and neck of the femur and a pathological dislocation of the upper end of the shaft of the femur upward on to the ilium. The acetabulum likewise revealed considerable destruction with upward erosion on to the ilium. There was no evidence of recent activity.

Operation. On October 24, 1929, a Steinmann pin was inserted in the lower end of the femur and traction applied.

Operation. On November 11, 1929, an arthrodesis of the hip after the method described was done.

The roentgen-ray and clinical examination, March 10, 1930, revealed solid bony ankylosis of the hip.

Operation. On March 17, 1930, a subtrochanteric osteotomy was done followed by gradual bending into the corrected position.

CASE 8. D. F., aged 8 years, was admitted to the hospital October 11, 1929, complaining of a limp and a shortening of the right leg. In 1925 at the age of 4 years, the parents first noticed a slight limp in the right leg. Shortly after this the patient began complaining of pain in the right hip and it was noticed that she had a daily afternoon rise in temperature. The above symptoms gradually increased in severity and 1 year later a hip spica was applied. This was maintained for an additional year after which traction was applied for 7 months. Finally an operation was performed. Eight weeks later, the patient was allowed up and has limped ever since.

Physical examination disclosed a fairly well developed and nourished girl of 8 years, with a 70 degree flexion, adduction, and external rotation deformity of the right hip. The patient walked with crutches on the toes and ball of the right foot. There was 30 degrees' motion in flexion and extension of the hip but all other motions were nil. The femur was 2½ inches short.

The roentgen-ray examination, October 11, 1929, revealed the right hip joint to have been the site of an extensive destructive process with complete destruction of the head

and neck of the femur. There was an upward erosion of the acetabulum on to the wing of the ilium and no evidence of ankylosis.

Operation. On October 31, 1929, a section of the adductor muscles and the insertion of a Steinmann pin in the lower end of the femur followed by traction was done.

Operation. On December 2, 1929, an arthrodesis of the hip in wide abduction was performed.

The roentgen-ray and clinical examination, March 22, 1930, revealed definite evidence of beginning bony ankylosis.

CASE 9. E. P., aged 10 years, was admitted to the hospital January 18, 1929, complaining of deformity of the left hip. In 1925 at the age of 6 years, the patient suddenly developed acute pain in the left hip associated with tenderness. There was a slight elevation of temperature but otherwise no constitutional symptoms. He was confined to bed for several weeks after which he walked with a limp. One and one-half years later, several sinuses developed in the region of the hip which drained until 8 months previous to admission.

The general physical examination revealed a somewhat undernourished boy of 10 years but was otherwise essentially negative. The patient walked on the toes of the left foot with an awkward limp and an associated extreme lordosis. There was a 48 degree flexion and 14 degree adduction deformity of the hip with a few degrees of motion in flexion and extension. All other motions were nil. There was no sensitiveness about the joint. The left lower extremity revealed 2 inches of shortening.

The roentgen-ray examination showed the left hip to be the site of an extensive destructive process with complete disappearance of the head and greater portion of the neck and invasion of the acetabulum.

Operation. On February 25, 1929, the deformities of the hip having been corrected by traction, an arthrodesis, placing the femur in wide abduction, was done. A solid hip spica was applied.

The roentgen-ray examination, August 23, 1929, showed beginning ankylosis. Gradual weight bearing was started. Four days later check-up measurements showed the hip to be drifting into a position of deformity. A solid walking spica was applied and the patient was discharged.

March 26, 1930. Readmitted for femur lengthening. The position of the hip had remained unchanged.

The roentgen-ray examination showed a moderate degree of ankylosis present.

CASE 10. F. H., aged 10 years, was first seen in the Out Patient Department November 6, 1925, complaining of pain in the left hip and a limp. One year previously the patient fell injuring the hip. This was followed by slight pain and a persistent limp. He was removed to a hospital where a diagnosis of tuberculosis was made and conservative treatment carried out. The patient walked with a slight limp on the left. The hip was slightly flexed with limitation of motion in all directions associated with muscle spasm. There was no sensitiveness about the joint, however. Roentgen-ray examination revealed a subepiphyseal destructive process of the neck of the femur with apparently no involvement of the joint proper.

On January 29, 1926, the patient was admitted to the Shriners' Hospital because of an increasing flexion deformity of the hip and increasing destruction of the neck of the femur as shown in the X-ray.

Operation. March 15, 1926, a drainage of the neck of the femur through the great trochanter was done.

March 6, 1928. The patient had been under observation for 2 years during which time two abscesses were aspirated and two sinuses had developed, one over the great trochanter and one in the groin. The hip was in a position of 25 degrees' flexion, 14 degrees' adduction, and slight internal rotation.

May 2, 1929. Readmitted for drainage of an abscess in the region of the great trochanter.

The roentgen-ray examination revealed complete destruction of the head and neck of the femur with involvement of the acetabulum. The hip was in a position of 44 degrees' flexion, 27 degrees' adduction, and slight internal rotation.

Operation. On May 18, 1929, an incision and drainage of the abscess was done.

Operation. June 3, 1929, an arthrodesis of the hip after the manner described was done, the wound being packed wide open. Microscopic examination of the tissue removed showed active tuberculosis.

On September 24, 1929, the patient was discharged in a walking hip spica. Clinically the hip appeared to be solid. The roentgen-ray examination showed definite beginning bony ankylosis.

October 18, 1929. The patient returned with the entire wound broken down and discharging. There was definite motion of the hip joint present.

May 7, 1930. Since admission the patient has been treated by means of traction, heliotherapy, and rest. One small sinus still remains. Motion in the hip joint is present. The roentgen-ray examination shows no evidence of ankylosis. The patient's general condition is excellent.

CASE 11. J. D. W., aged 12 years, was admitted October 19, 1928, complaining of a deformity of the right hip. In 1920 at the age of 4 years, the patient fell, bruising the right hip. He was able to get around but complained of considerable pain in the region of the hip and walked with a limp. During the next 4 years the patient continued to have pain in the hip often referred to the knee with an associated limp at irregular intervals. The symptoms gradually increased in severity until at the end of that time a plaster cast was applied and maintained for 1 year. The patient was then allowed to walk with crutches. Since that time at intervals of about 1 year, three abscesses have developed, associated with swelling of the hip, pain, and temperature, necessitating drainage. At the time of admission the patient still had one sinus present.

The general physical examination revealed an undernourished boy of 12 years but was otherwise essentially negative. The patient walked on the toes of the right foot with an associated limp. The hip was held in a position of deformity of 65 degrees' flexion and 15 degrees' adduction. There were a few degrees of motion present in flexion and extension. There was one draining sinus over the posterior aspect of the hip. The femur was 2 inches short.

The roentgen-ray examination revealed marked destruction of the right hip joint with disappearance of the greater portion of the head and neck of the femur and also involvement of the acetabulum.

Operation. On November 12, 1928, an arthrodesis of the hip after the manner described, was done. A posterior approach was employed and the wound was packed open.

On May 11, 1929, the clinical examination showed slight motion still present in the joint. There was present one draining sinus in the operative scar. A walking hip spica was applied.

June 30, 1929. The spica was removed. There was no evidence of ankylosis either clinically or by roentgen-ray examination. Weight bearing without support was started and the patient discharged.

March 19, 1930. The patient returned 16 months after operation with the general condition very much improved. The sinus had been closed for 3 months. There still was slight motion present in the hip but check-up measurements showed no recurrence of deformity.

SUMMARY

1. In this article we have described a method of arthrodesis of the hip in massive destruction of the joint. This method is based on fundamental principles of treatment, namely the apposition of wide areas of cancellous bone under complete fixation and firm pressure. Failure is most often due to neglect of these fundamental principles.

2. The special method which we have devised calls for wide abduction of the limb. No attempt is made to obtain the best functional position of the extremity at the time of arthrodesis.

3. Correction of the abducted position is secured by transverse osteotomy and gradual bending of the callus. This method of osteotomy is simple, minimizes the dangers of displacement of the fragments, and permits frequent inspection and measurements of the extremities to determine the best functional position for weight bearing.

TORSION AND VOLVULUS OF THE STOMACH

WAYLAND A. MORRISON, M.D., F.A.C.S., Los Angeles, California

TOTAL volvulus and complete torsion of the stomach are rare lesions. Recognition of them as pathological entities is comparatively recent. Berti, in 1866, was the first to report the condition of complete volvulus found in a patient at autopsy. Berg, in 1895, was the first to operate. He reported 2 cases, 1 total and 1 partial. Since then others have been reported occasionally. Kocher, who had a personal case of total volvulus in 1914, reviewed the literature of the subject and found 28 cases. Up to 1924 additional instances were reported by Niosi and Siegel, that of the latter being in a child 2 years of age. In 1923, Max Thorek, of Chicago, reported a case of total volvulus and summarized the literature. Laewen, in 1927, stated that there were about 40 known cases.

Thorek's case gives a typical picture of acute volvulus in a woman 77 years of age. There was no previous history of gastric trouble. She had been constipated for 3 days and had eaten heartily of indigestible food. After examination the case was diagnosed as acute intestinal obstruction and stricture at the cardiac end of the stomach. When the abdomen was opened the condition found at first suggested a twisted, high ovarian cyst, but was found to be a stomach volvulus of 270 degrees on the horizontal axis. The pylorus was displaced to the left and the transverse colon was vertical and above the lesser curvature. Detorsion was effected following puncture and evacuation and a gastropexy done according to the Rovsing method. The patient made a good recovery.

The necessity arises here of distinguishing between volvulus and torsion. Becker deals with this aspect, differentiating between volvulus (Magenverschlungung) and torsion (Magenverdrehung). According to him a true volvulus means a rotation of the whole viscus between the pylorus and cardia, these being the points of suspension, while torsion indicates that rotation has taken place about the other axis. Becker states that several of the cases reported in the literature as volvulus are really partial torsions, including those of Weiss and Meisels, in neither of which were there any acute, stormy symptoms. If this differentiation between the two terms is to be accepted, my own case would have to be reported as complete torsion with obstruction rather than volvulus.

The factors most usually associated by different authors with either of these conditions are gastroptosis, great mobility of the stomach, an abnormal elongation of the lesser omentum, an exaggerated filling of the stomach with gaseous distention, a physical effort or fall, with increase of abdominal tension, repeated violent vomiting, partial and limited contraction of the different layers of the gastric wall, or any neighboring disturbance which pushes the greater curvature upward and to the right and the stomach out of place. Gas in the colon may be an important factor of the last type. The accumulation of air in the splenic angle of the colon acting directly on the stomach and by pressure on its vertical part may start a volvulus or torsion which, according to conditions, may be partial or total. Torsion to a lesser degree is not infrequent, and since there are no acute symptoms, may pass unperceived.

The pylorus has not the same fixity as the cardia and more easily permits complete rotation from below, upward, or toward the cardia. The only structure that offers any particular resistance is the phrenogastric ligament which, however, does not seriously hamper movement of the

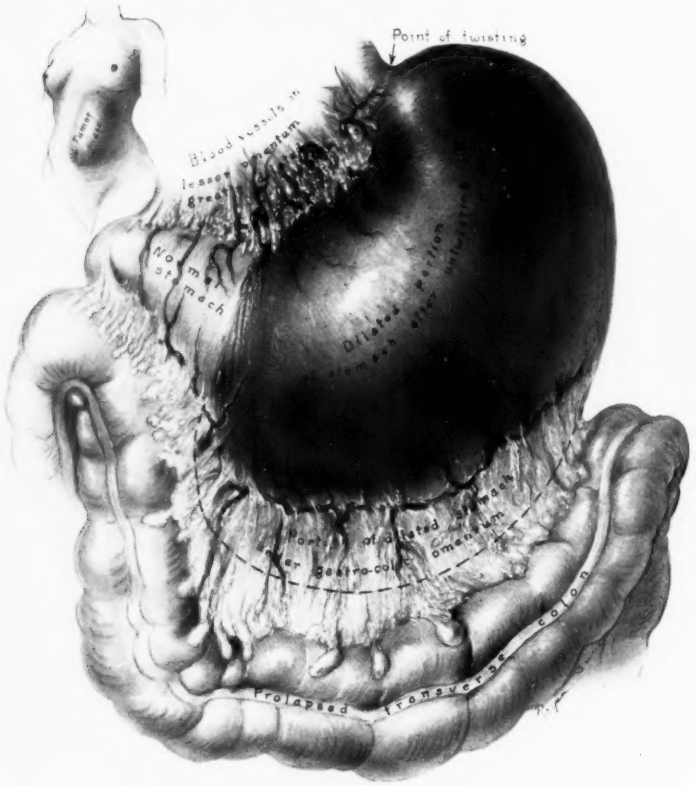

Fig. 1.

greater curvature on the axis of the lesser curvature, which is the usual axis of twisting when traction is sufficiently strong. After a certain amount of rotation the mobile pylorus may come into contact with the cardia.

Kocher thinks that the immediate cause is overfilling of the stomach. The mechanical torsion is caused by movements of the body and by vomiting, owing perhaps to the weight of the distended, displaced organ.

Twisting is more likely to result when the stomach is bilocular as in the case of ulcer or tumor. Many reported cases of partial volvulus are of this type.

The factor which has been mentioned by several of the German writers on this subject, as contributing to the occurrence of volvulus of the stomach, is constitutional weakness of the left half of the diaphragm. In Laewen's patient this was found to be the case.

Choisy and Babaiantz in their own case of intermittent volvulus could find no other causal factor than intestinal distention which was coincident with the observed twisting and disappeared with it. This seemed to be the factor in my case.

In total volvulus or torsion when the abdomen is opened the posterior wall of the stomach presents itself covered by the mesocolon. The stomach orifices are twisted and occluded. The distended viscus appears as an enormous, congested, discolored, cystic tumor bulging into the abdominal incision.

The transverse colon, spleen, and pancreas may be greatly displaced or even twisted with the stomach; the transverse colon may take a vertical position. The greater and lesser omentum are usually involved and may rupture with a blood effusion into the peritoneal cavity.

In partial volvulus the pyloric part of the stomach is usually twisted. In some cases the

Lesser omentum twisted and blood vessels distended
Point of twisting
Splenic flexure of colon
Oesophagus
Duodenum
Outline of normal portion of stomach
Gastrocolic omentum covering stomach
Transverse colon
Thick walled dangerous cyst (twisted portion of stomach)

Fig. 2.

pyloric and cardiac parts may twist in different directions. Koppenstein's and Nockold's cases are examples of this type.

As a general rule the circulation is not greatly disturbed and the blood supply of the stomach appears to be more or less resistant to the torsion. In my own case strangulation of the vessels supplying the stomach was a very notable feature and even after reduction the circulation was not restored. Although I have looked into the literature carefully, I have not been able to find a case which presented such an extreme interference with the blood supply.

If death or operation does not cut the process short, it usually ends in perforation of the stomach wall by fissure or rupture due to extreme stretching from distention. If there is a weak spot in the wall, rupture is likely to occur there and in 2 cases such perforations occurred in ulcerous areas. In Helsinger's case the serosa was found ruptured in several places.

There are no pathognomonic symptoms of volvulus or torsion of the stomach. Usually true volvulus or complete torsion presents a sudden onset with rapid evolution of symptoms. There is acute epigastric pain, retching, absence of peristaltic movements, rapid pulse, temperature not high, and perhaps cyanosis of the face. The general symptomatology is usually that of a high occlusion or of a perforated ulcer.

Very few cases of volvulus of the stomach have been diagnosed as such pre-operatively. The most usual diagnoses are ileus, pancreatitis, strangulated ovarian cyst, perforated ulcer, etc. In a few cases, such as those of Choisy and Babaiantz and others, the diagnosis was made by X-ray investigation.

Siegel states that in his case the diagnosis was evident, as after lavage of the stomach and withdrawal of a large quantity of fluid, the original distention reappeared after a few hours.

Pilcher says that there should never be any difficulty in immediately diagnosing the condition whenever there is vomiting which suddenly stops and is followed by an immediate increase in distention as the result of the production of gas due to a changed chemical reaction in the stomach.

The symptoms arising from acute volvulus or torsion call for immediate operative interference. After the abdomen is opened and the presence of

a volvulus is verified, the accepted treatment is puncture of the stomach, evacuation of gas and fluid, detorsion, and gastropexy. This procedure applies when there is a true idiopathic volvulus but if the condition is rather a torsion due to a stenosis or some other condition, the pathological lesion should be treated according to the accepted methods. Fistulization may be indicated as a complementary operation.

In the case of early operation the prognosis is good. Of 28 cases collected by Kocher, 18 were operated upon and 13 recovered. Thorek's review showed that operation resulted in recovery in 60 per cent of the cases.

The case I wish to report is really one of almost complete torsion of the stomach. It is of interest because it presents an unusual condition. There was a complete interference, with stoppage of the blood supply to the organ which resulted in the patient's death. The history of the case is as follows:

A housewife aged 63 years was found lying in bed, complaining bitterly of severe general abdominal pain. She stated that the day before, following an unusually heavy meal, she began to have a slight discomfort in the abdomen, localized on the left side in the upper quadrant. The pain increased and by night became quite severe. She vomited many times. The vomitus contained the food eaten at noon, was sour, but did not contain blood or "coffee grounds." She then became suddenly greatly distended, the nausea continued but there was no more vomitus. Fluids taken were immediately returned. She was given a high enema but without results. The distention remained and it was necessary to siphon the fluid. She had always been well until her present trouble and did not remember ever having had attacks of indigestion. She had typhoid as a child but no other serious illnesses. There were no previous operations.

Physical examination disclosed a well developed elderly woman, apparently desperately ill. Examination of the head was negative except for dry, parched tongue, and anxious facial expression. The heart and lungs were negative. Pulse was 108, respiration 24. The abdomen was greatly distended and tympanic throughout except in the upper left quadrant where a large oval mass could be outlined. This was dull to percussion and the abdomen was extremely tender. Muscle spasm was marked. The blood picture was as follows: Hæmoglobin, 89 per cent; red blood cells, 5,768,000; white blood cells, 16,200; polymorphonuclear neutrophiles, 85 per cent. Urinalysis showed: specific gravity, quantity not sufficient; albumin, 2 plus; sugar, negative; acetone, 2 plus. Microscopic examination of the urine showed a few hyaline casts, an occasional finely granular cast, and a few pus and blood cells.

Operation was advised and performed at once. The abdomen was opened by an upper left rectus incision. A large oval mass the size of a football presented itself and at first appeared to be a large, strangulated, high ovarian cyst. The wall of the cyst was dark and it was impossible to deliver it through the abdominal opening. A trocar was inserted and three quarts of brownish fluid aspirated. It was then possible to untwist the mass which was found to be a greatly dilated stomach, four-fifths of which was twisted upon itself. The blood supply was entirely obstructed and failed to return after reduction. As the patient's condition was desperate, it was necessary to place a tube in the stomach, to make a quick examination for other pathological lesions, and immediately to close the wound. The patient died a short time later and, unfortunately, an autopsy was refused.

The hurried examination did not reveal any cause for the twisting. There was no pyloric obstruction, no adhesions, and no tumor mass in the wall of the organ. The diaphragm was normal. The mechanics in this case are, I believe, similar to Kocher's ideas—the rotation was caused by a greatly distended stomach due to overeating and to gas formation. The stomach was rotated during the act of vomiting.

Fortunately rough sketches were made of the condition at the time and I have had the artist make completed drawings.

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THE SURGICAL CORRECTION OF CLEFT LIP AND PALATE

ALBERT D. DAVIS, D.D.S., F.A.C.D., B.Sc., M.D., F.A.C.S., San Francisco
From the Division of Plastic Surgery, Stanford University School of Medicine

THE great number of operative failures in the surgical treatment of congenital cleft lip and palate, estimated at 70 to 80 per cent, should arrest the attention of all surgeons and give cause for serious reflection. Many prominent surgeons have abandoned palatoplastic surgery because of the preponderance of such failures, and yet at the present time one still finds osteopathic surgeons, general surgeons, as well as dentists, devoting part of their time to the correction of these deformities. It is easily understood, therefore, how differences of opinion may arise as to time of operation, order of procedure, and technique to be employed. A review of the literature from different parts of the world seems to indicate that there is probably no other field of surgery in which such a variance of opinion exists. In the United States the surgeons are divided chiefly between those who are followers of Brophy and those who are opposed to his technique.

In England, the surgeons almost to a man, are opposed to the Brophy operation, even though the Lane operation is practically obsolete. Gaillard y Nogue, a Spanish stomatologist, disagrees with the Brophy technique and advocates the excision of the premaxillary bones, as did Mills and Humphrey, E. W. H. Groves, and others. Addison and Traynor, of England, advocate operation within the first to the third year, while Brophy advises early operation. Veau and Lascombe of Paris close only the anterior part of the cleft bones (as do many American surgeons), leaving the posterior part of the cleft without wiring. Other instances of disagreement might be cited but if it is admitted that anatomical normality and perfect function are the objects sought for, as well as esthetic appearance, there must be some fundamental laws by which these objects may be attained.

Congenital cleft palate is a deformity in which all of the normal tissues are present in the palate at birth, and although ununited, contain every essential necessary to produce anatomical and functional normality. Therefore, if the surgeon who attempts operation upon these defects realizes that he has enough, but only enough tissues with which to restore normality, every precaution should be taken to obtain that end. Fundamentally there is one law which is constant—if the bony arch is cleft it must be united, prior to other operations. This holds true for either a unilateral or a bilateral cleft. While some surgeons do not follow this procedure, there are sufficient reasons to make it a fundamental starting point. From a surgical standpoint, the ununited bones are an ununited fracture, and should be so treated—approximated, contact surfaces freshened, compact bone removed, bleeding cancelled, bone should be placed in contact with bone, immobilized, and covered with mucoperiosteum. Mere approximation of the bony cleft without union is unsurgical, unscientific, and leaves a deformity which, even though considerably lessened, is not corrected.

Every cleft palate patient, whether operated upon or not, requires orthodontia. If bony union has not been attained, and expansion of the dental arch is necessary, the orthodontist finds that, in

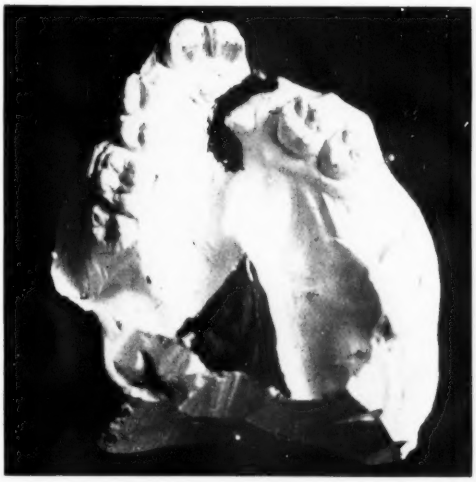

Fig. 1. Plaster cast illustrating approximation of bony cleft without union. The lip has been closed over the approximated bones at the first operation. There is an oro-nasal sinus under the lip. The soft palate has been pulled forward in an attempt to obtain closure at the expense of speech. The tuberosities are spread widely. Note the irregularity of the teeth in spite of the fact that no ires had been used in previous operations. Failures in this case were due to the fact that the bones were not united at the first operation. A greenstick fracture operation is necessary.

Fig. 2.

Fig. 3.

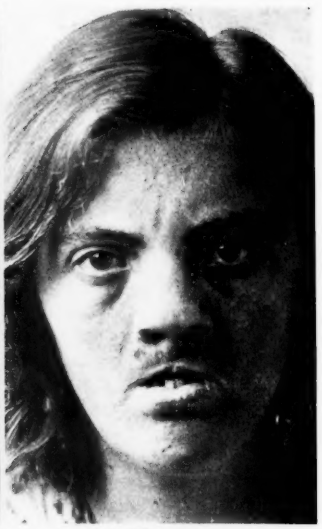

Fig. 4.

Fig. 2. Case showing bony union obtained at expense of normal bony arch. Most of the premaxillary bone has been cut away. The lateral halves of the maxillæ have been forced together in front into almost a "V" shape with a large space between. The tuberosities are widespread.

Figs. 3 and 4. Profile and front views of same patient as in Figure 2, showing marked deformity present in spite of many operations. It will be necessary to resort to some form of prosthesis after lip surgery is finished. Failure occurred in this case because the fundamental principles of palatal surgery were either disregarded or were misunderstood.

spreading the arch, the clefts are increased at the expense of obtaining normal occlusion. Successfully operated upon, a cleft bony arch presents no more of a problem for the orthodontist than do some of the non-congenital deformities. Moreover, the entire ground-work in restoring normality for lip, nose, and soft tissues of the palate depends on a perfectly united bony arch. A perfectly united bony arch may be so widely spread in the region of the tuberosities as to render the subsequent closure of the cleft soft tissues a very difficult operation. This spreading occurs often-

Fig. 5.

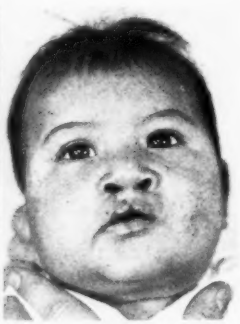

Fig. 6.

Figs. 5 and 6. Tripartite type of cleft lip and palate with premaxillary protrusion, before and after correction. At the first operation a united, well rounded bony arch was formed. Six weeks later the lip was closed. The nose may have to be raised later.

Fig. 7.

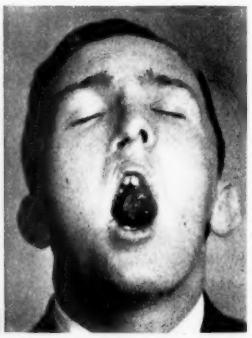

Fig. 8.

Fig. 7. Large cleft of soft tissues unoperated upon previously. The lip was closed in infancy. Note wide flat ala on right. Also irregularity of teeth.

Fig. 8. Same patient as shown in Figure 7 after palate operation.

Figs. 9 and 10. Roentgenograms of cleft palate, child 8 years old, who had had several operations since birth. The lip was closed 24 hours after birth. The bones were approximated but not united. Attempts made to close the soft tissues resulted in failures. In order to obtain a normal bony arch, a greenstick fracture operation was done (Fig. 10), and the freshened edges of the bony cleft held in place with silver wire.

times as a result of the use, as a retainer, of a single wire suture through the anterior part of the cleft bones. The malar processes act as pivots when leverage is exerted on the lateral parts of the cleft maxillæ, and as the anterior parts of the maxillary bones are drawn together, the posterior ends move apart. Unless this separation posteriorly is guarded against, the end-result will be a short, tense, soft palate with which normal speech cannot be attained. In order to overcome this difficulty, the maxillæ are wired high up above the alveolar ridges both posteriorly and anteriorly. Upon this important step depends the success of the soft tissue operation. In 1884, Dr. Brophy used a steel clamp for the mechanical approximation of maxillary clefts. This was discarded a few years later. Hammond and Roberts then came out with a modification of the Brophy clamp and were followed by other mechanical devices for causing pressure on the cleft bones. The latest of such devices is one designed by Fox, a dentist, and consists of an adjustable bow to which are attached three pronged pads, one for each buccal surface, and one for the labial end of the long side of the palate. By tightening the set screws and the gradual pressure of the attached spring, approximation is gradually obtained. The elimination of shock, dietary upsets, and other complications, is claimed for these methods. Wiring, however, is used by the majority of operators. To repeat, there must be provided a well rounded, united bony arch with tuberosities held in normal positions if the operations which follow are to be successful.

Observations made over a long period of years indicate that the greatest number of failures in cleft lip and palatal surgery are in those cases in which there has been failure in the primary operation. If it is considered that an infant at birth has only 50 per cent of the calcium deposits in the jaws, it is easily conceived how the cleft bones, by digital manipulation, may be bent and moved to position before wiring. (This may be accomplished up to, and including the sixth month of age.) After this time it is usually necessary to place the wires in position, move the

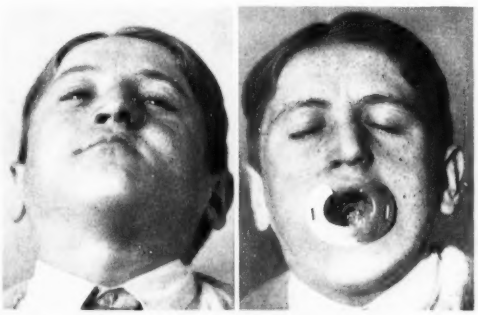

Fig. 11, left. A patient with normal lip but cleft of soft palate. Note the deformity of the right ala. There was no cleft in the maxillæ.

Fig. 12. Same case as in Figure 11, showing the large oropharyngeal opening. This child's speech is defective due to his inability to close the postpharyngeal space, although the soft palate operation was done prior to speech development. It will be necessary in this case to lengthen the palate and institute speech training.

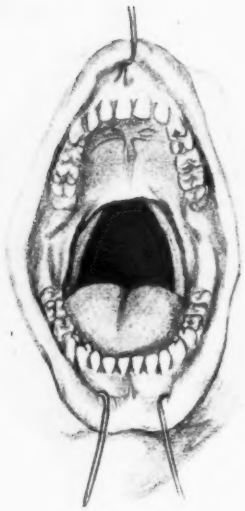

Fig. 13.

Fig. 13. Diagrammatic drawing showing short, closed soft palate. Note large pharyngeal opening. Correct speech can never be accomplished unless the palate is sufficiently lengthened so that the patient is able to close off the postpharyngeal space in forming consonant sounds.

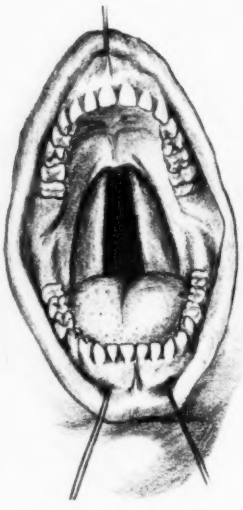

Fig. 14.

Fig. 14. Same as in Figure 13 with the patient pronouncing the word "ah." Note the palato-pharyngeal muscles in contraction.

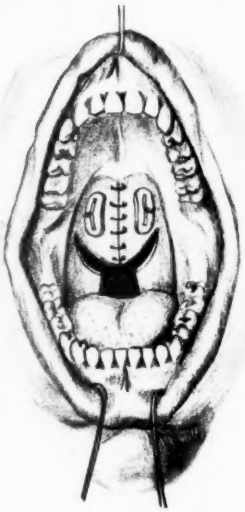

Fig. 15.

Fig. 15. Shows operation for lengthening palate complete. Two-thirds of the palato-pharyngeal muscles are used to lengthen palate. Brophy operation.

bones as closely together as possible, and at various intervals, tighten the wires until the bones are in apposition when flaps are made, the edges freshened, and union takes place. The preferable time for the Brophy bone operation is usually about the sixth week. At that time the muco-periosteum (which must be raised and made into flaps) is far enough advanced to warrant successful surgery. The use of large bone pressure forceps upon the lateral alveolar ridges to produce greenstick fractures in early infancy cases is unnecessary. Greenstick fractures are often made in late cases to obtain bony union. This is done by chiseling through the outer alveolar plate rather than with pressure forceps.

It is not difficult to conceive of the errors which may occur in the bone operation. With differences of opinion as to technique, desired end-result, and the varieties of clefts requiring bone operation, failures creep in even when the services of trained surgeons are available. Time of operation is most important. If the bone operation is done in early infancy, three great benefits

Fig. 16. Plaster casts of boy aged 18 years. *A* shows condition of palate prior to Brophy lengthening operation. *B* shows result obtained by utilizing two-thirds of palato-pharyngeal muscles. A long flexible palate was obtained.

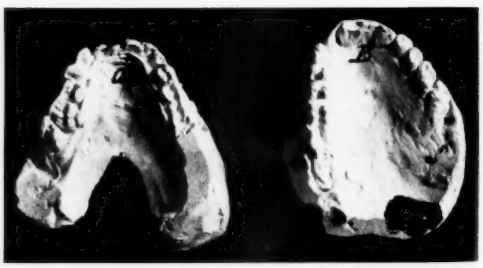

Fig. 17. Plaster casts of girl aged 20. *A*, prior to lengthening palate. *B*, after operation.

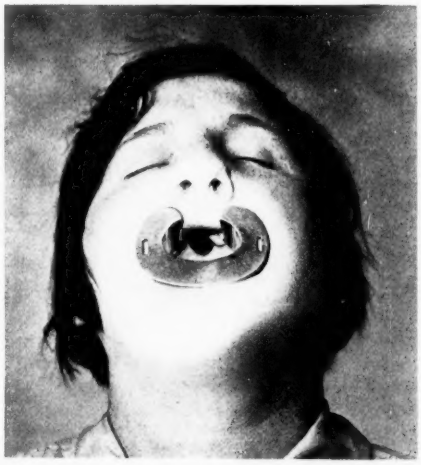

Fig. 18. Case of "inoperable" palate. History shows many attempts at closure with failure. Dense scar tissue with actual loss of tissue due to sloughing. Patient insisted on attempt to close palatal tissues. The series of illustrations (Figs. 19, 20, 21, and 22) show what was done in this case.

accrue: (1) less surgical risk, because of underdeveloped nervous system; (2) easier closure, because of limited ossification of bones; and (3) better results, because of establishing normal foundation for lip, nose, and soft tissues of the palate. These facts being admitted, bone operations in early infancy are imperative for future results. A pediatrician, cognizant of the importance of this work, is uniformly employed in the pre-operative and postoperative care of all infantile cases. Co-operation between pediatrician and surgeon is of the utmost importance. Higher mortality rates are practically invariable among those surgeons who do not employ the services of a pediatrician.

Routine roentgen-ray examination of the thymus gland should be made in all cases, prior to subjecting the patient to anæsthesia. Henske reports a series of 54 cases, 11 of which showed definite thymus enlargement. Peterson and Miller report that 40 to 50 per cent of newborn infants have enlargement of the thymus gland. Early

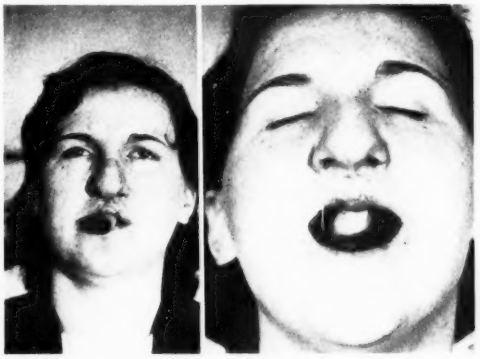

Fig. 21, left. Pedicle detached from hand, receiving blood supply from the undersurface of the lip.

Fig. 22. Pedicle attached to posterior part of palate. Since this series was taken the pedicle has been opened up and attached on both sides of the cleft. There remain a few slight "trimming" operations prior to finishing.

Fig. 19. Tubed pedicle which has been formed on abdomen.

Fig. 20. Transfer of pedicle to mouth by utilizing the arm as a "carrier."

Fig. 23.

Fig. 24.

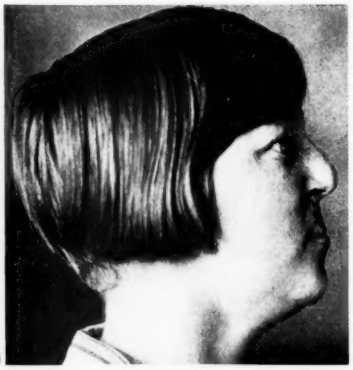

Fig. 25.

Figs. 23–25. This series of photographs presents a case in which the operators were overzealous in the removal of scar tissue from the upper lip with the result shown in Figure 23. It was necessary to transfer a large triangular flap from the lower lip to the upper in order to obtain any degree of normality (Fig. 24). Figure 25 shows change in profile obtained by the operation.

hospitalization with a definite course and technique of feeding is an essential in obtaining the best results. Isolation for 2 to 3 weeks prior to operation prevents the dangers of childhood disease.

Following the bone operation, the lip is closed. While the lip may be done at any time, the preferable time is from 6 to 10 weeks later. The important fundamental principles underlying lip surgery are: (1) obtaining the correct flaps, (2) obtaining fullness in the center, (3) shaping the nose, (4) avoiding scar, and (5) relieving tension.

Too much stress cannot be laid on the formation of the flaps in closing clefts of the lip. In the lip as well as in the palate, there are enough tissues present to obtain a normal lip, but there is no excess. The lip, however, being flexible permits a latitude of excision comparable to few other tissues without interference with esthetics or function. Operations for the closure of the lip date back as far as the time of Celsus, who lived in the period between 42 B.C. and 37 A.D. Various forms of lip flaps have been designed by surgeons since that time. Malgaigne, Dieffenbach, Nealton, Mirault, Owen, Koenig, Rose, Thompson, Ladd, Mayo, Simon, Brophy, and others have outlined methods for the formation of flaps to close clefts of the lip.

Regardless of the design used, closure without obtaining normality is considered a failure. A certain degree of shrinkage must be expected. Broad, flat surfaces must be used in approximation, and an equalization (in length) on both sides is necessary. The muscle elements of the lip must be united so that the normal thickness is present when healing occurs. Of the various designs of flaps used, practically all except the Brophy operation depend upon the sacrifice of some portion of the lip. Incisions carried around the alæ of the nose, or those which involve the cheek are impractical and usually unwarranted. Modification of the Mirault or Owen types of flaps are useful in some cases, but if the nostril is involved they are faulty. In the Rose operation, crescent shaped masses of tissue are excised from each side. Thompson's operation is somewhat similar and requires the removal of considerable tissue. New's operation is a modification of the Thompson procedure. In experienced hands these operations allow harmonious relation with the lower lip, but in many cases the angle to angle width of the lip is shortened, and the profile gives every appearance of a protrusion of the lower lip. Veau and Lascombe (Paris) excise equal parts of the upper quadrant of the lip and under portions of the alæ extending their incisions around the alæ on each side, forming the prolabium into an irregular cone shape with definite angles. While similar in type to the Brophy operation, more of the lip and prolabium are sacrificed to attain the desired result. The same surgeons (Veau and Lascombe, Paris) convert the complete double clefts into partial clefts (at the same time the wires are placed through the bony cleft) by freshening the lateral sides of the prolabium and the lip and suturing, leaving the lower edge of the prolabium untouched. Two months later the lip is closed, a modification of the double Owen operation being used. The

mucosa on the under surface of the prolabium is utilized in the formation of a lip lining. The Brophy operation utilizes practically all of the lip tissues. A small amount of skin and mucosa are sacrificed a short distance up in the nostril to allow the correction of the broad, flat nostril, and excision of redundant mucosa is made at the junction of the flaps below.

About 75 per cent of single clefts of the lip occur on the left side. The ala on the cleft side is flattened and provision for its correction must be made. Moreover, a floor must be provided for the nose, otherwise an oro-nasal sinus (so often seen) will result. Each case is a law unto itself which again complicates this type of surgery for the beginner, or for the surgeon who sees a few cases each year. The author has had cases of patients who have been operated upon previously 35, 24, 18, 14, 11, 9, and on down to 6 times with failure. Is it not time that a plea for a definite technique in cleft lip and palate surgery be made?

Most important of all the steps in cleft lip surgery is to secure a correct vermillion border. Too often the operator makes the lip longer than required for a good cosmetic result. Another common error is in the production of a notch in the lip at point of union of the flaps. When a superabundance of skin has been brought down to the median line, some of it must be removed to prevent skin and mucous membrane from being united. A fundamental rule, applying to all types of cleft lip, is that in suturing the flaps, skin must meet skin, and mucosa must meet mucosa. Skin flaps must be split in such a way that depression does not occur. Central fullness of the lip is obtained by properly shaping the flaps when cut. More mucosa is required on the "long" side in single clefts. The avoidance of tissue trauma, careful approximation, and relief of tension are fundamental in preventing scar formation. Vessels are taken up with tiny hæmostats, with as little tissue crushed between the beaks as possible. Horsehair is the material of choice for sutures, and tension is relieved by the use of the Logan traction bow. Early removal of sutures (third to fifth day) prevents scarring, the bow being left in place until the tenth day.

Full consideration must be given to shaping the nostril in clefts of the lip. Whether the cleft be single or double, there is nearly always some involvement of the nares. Even when the cleft is incomplete, a ridge, a notch, a congenital scar, or a flattened ala are often seen, and it is necessary to produce temporarily a complete cleft in order to attain a result. Oro-nasal sinuses on the under surface of the lip are due to failures in constructing a floor for the nostril involved. The mucosa must be united at the time of closure in order to avoid this error. Too often a flattened, mal-shaped nostril detracts from an otherwise perfect esthetic result. Correction of these defects vary according to type. Frequently an incision carried around the entire ala, undercutting in both directions and making a turn over subcutaneous flap, will raise the alar floor and distal margin to conform with the opposite side, after which the ala itself may be re-shaped. It is often necessary to remove or rearrange the lateral alar cartilage in order to overcome the depressed ala. Skin grafts are rarely necessary unless the deformity is so great that other methods fail. In selected cases, a Thiersch graft properly used gives form and contour to an otherwise hopeless deformity. Following a double cleft with marked protrusion of the premaxillary bones, raising the tip of the nose by the V-Y operation of Brophy, gives excellent results if strict attention to detail is paid. Nasal corrective operations are usually delayed until after the eighth year.

Clefts of the soft palate occur in twelve different types. In speaking of clefts of the soft palate reference is made to the soft tissues of the palate rather than to the velum alone. These clefts vary from a small cleft of the uvula to the extreme double clefts involving all of the soft parts from the uvula to and through the alveolar process on both sides. Closure of the minor clefts is comparatively simple. It is surprising to note, however, that a cleft involving only the uvula, if not operated upon prior to the time the child learns to speak, often results in a typical cleft palate speech defect, which can be corrected only by operation followed by speech training. When the cleft extends anterior to the horizontal plates of the palate bones and into the palatal processes of the maxillæ, many failures occur. The soft tissues comprising the covering of the hard palate and the velum itself are thin, flexible, and resilient. Due to the muscular action in speaking, breathing, swallowing, sucking, etc., and as a constant buffer for the tongue, these tissues are rarely at rest. For this reason, an operation, which closes the palatal defect perfectly at the time may break down due to the see-saw action of the lateral muscular flaps acting independently. Some form of splint must be used to prevent failure of union. This is best accomplished by the use of lead plates and silver wires as designed and used by Brophy since 1883. Not only do the plates and wires act as a splint to prevent movement but also to prevent the stitches from cutting out.

Moreover, the twisted ends of the wires bent down upon the plates are uncomfortable to the tongue and in the subsequent feedings the tongue will be prevented from coming into contact with the freshened edges of the palate to make suction. The proper use of these wires and plates places in the discard the use of temporary artificial palates and other devices for protection. It must be remembered that the use of lead plates and silver wires is not for the purpose of creating forceful approximation of the flaps. They should render inactive the muscular elements of the soft palate if properly placed, and allow relaxation of the tissues without resorting to lateral incisions in the palate. Silver wire No. 22 American gauge is used. These wires are inserted by drawing each through pilot sutures of braided silk. The posterior wire should pierce the tensor-palati muscle, far back from the freshened edges and must not be twisted tightly enough to cut off the circulation and cause sloughing of the tissues.

Many surgeons feel that if by operation, closure of the cleft is obtained, a perfect result is assured. Unfortunately, this is not true. Closure may be secured oftentimes at the expense of the post-pharyngeal opening which remains so large, due to shortening of the palate at the operation, that distortion in voice tone, articulation, and vocalization occurs. A complete shut off between the oral and nasal cavities must be made possible if perfect speech is to occur following cleft palate operations. The fricative and explosive sounds,—K, G, Sh, T, D, etc.—may be made only when it is possible to close off the oro-nasal cavity.

The factors entering into the formation of a soft palate which is long enough to function properly, which is free from excess scar tissue and therefore resilient and flexible, are within the reach of every surgeon. Careful attention to detail, time, and sequence of operations, proper foundation in preceding operations are the necessary requisites if a normal soft tissue operation is to result. When, following the soft tissue operation, the palate is short, tense, and bound down by scar tissue, it may be lengthened by the utilization of two-thirds of each palatopharyngeal muscle and adding to the end of the palate, as designed by Brophy. By this operation the palate may be made long enough to close the postpharyngeal space, and by proper exercise and speech training the patient may learn to speak correctly.

The factors entering into perfect speech are a united soft palate, with its musculature intact, long enough to close the postpharyngeal space, flexible enough to control the amount of air passing through the oro-nasal communication, and resilient enough to allow normal nasal respiratory function. Dental prostheses to cover permanently the hard palate section of the soft tissues in order to obtain length in the posterior part are, to the author's mind, as poor a substitute for the use of the patient's own tissues as were the prostheses held in place by spectacle rims over the ears, for restoring defects in the face during the early part of the war. Most of the prosthetic devices in use could be discarded if properly planned operations were performed. Closure of secondary palatal defects in old, badly scarred cases presents a surgical problem which, although difficult, can be accomplished. The Ollier-Thiersch, Wolfe, and Gillies tubed pedicle grafts have all been used successfully by the author in some otherwise hopelessly inoperable cases. Brophy's operations, using the French gliding flap method, have proved of advantage in smaller defects.

The successful closure of the three main types of major clefts involving the alveolar process is dependent upon primary bone union without spreading the tuberosities. Many times a closure may be obtained when the bones are merely approximated, but mere closure of the defect is a poor substitute for a long, flexible palate. Too many operators are content in palatal operations if the lateral parts of the palate are united. The result may be a tense, scarred, short, drumhead-like palate, incapable of function, and yet be united. While such a palate is in some respects better than the cleft, normal speech (which should be the prime object of the operation) can never be attained. When a normal bony arch has been formed, the cleft in the soft tissues is narrowed and lengthened and the ununited parts assume a position which allows them to unite without tension, distortion, or resorting to lateral incisions which may affect the blood and nerve supply. The lateral flaps must be raised, by means of special periosteal elevators, from the midline of the fissure up near the gingival margins of the teeth and posteriorly as far back as the hamular process of the sphenoid on each side. Sometimes it is necessary to detach the hamular process entirely if the posterior part of the cleft is wide. When the flaps are properly elevated the former "U" shaped fissure becomes a "V." The edges of the cleft are then pared from the anterior part to and through the cleft azygos uvula. While this may seem of minor importance, the proper freshening of the cleft edges may mean the difference between success

and failure. Some surgeons attempt to split these edges with an incision parallel to the cleft, the knife passing between the nasal and the oral fold of mucosa. These edges tend to curl and, in splitting, islands of epithelial tissue are often unavoidably left, and when sutured, fail to unite, so that a defect occurs. It is much better to sacrifice a minimum amount of tissue with a direct through-and-through incision at right angles to the edge and thus insure a complete freshening of the entire length of the fissure. The wound is closed with horse-hair after the placement of the splint of silver wire and lead plates. Tension must be avoided both upon the horse-hair sutures and the splint. Unless the flaps are unusually thin, it is unnecessary to raise the mucoperiosteal flaps and to replace them in their beds a week or two prior to uniting them, in order to increase the blood supply. The patient is subjected to two anæsthetics, the flaps thicken and tend to curl, and the end-result is a thickened, heavy soft palate in which lightness, resiliency, and freedom of movement are the requirements. A study of the normal palate will show no signs of massive thick flaps posteriorly, and the more nearly normal anatomical result attained the more nearly functional result will be reached. To prevent the child from injuring the palate and lip by getting the fingers up to the mouth, Brophy's cuffs are used. They are made of pasteboard, lined with cotton or sheet-wadding, and extend from wrist to a point midway between shoulder and elbow. When pinned on firmly and cross-strapped with adhesive tape, free movement of the hand and shoulder is feasible but the elbow cannot be bent. They should be made to fit the wrist snugly so they cannot slip over the hand.

Feeding after operation is accomplished in the majority of cases by using a medicine dropper or rubber ear syringe, placing the milk on the back of the tongue and allowing time enough for swallowing without regurgitation. Irrigations of normal salt solution after feedings is important in operations involving the soft tissues of the palate. The Brophy nipple may be used prior to the bone operation, and the period between the time the lip operation is finished and the soft palate operation. Co-operation between the parents and the pediatrician during the intervals between operations usually results in a better surgical risk for the patient.

SUMMARY

1. In the light of our present-day knowledge the proportionate number of failures in cleft lip and palate surgery is too high.

2. A plea for a better understanding of the anatomy and functional activity of the palate is made.

3. The fundamental value of the Brophy bone operation in early infancy cannot be overestimated.

4. Failure of union results in: (1) abnormal bony arch, (2) abnormal occlusion of teeth, (3) short tense soft palate and many failures of union, (4) imperfect speech as result of number three, (5) imperfect foundation for lip or soft palate operation, (6) imperfect foundation for orthodontic treatment, with probable increase in cleft bones if movement is attempted.

5. Importance of time of operation and sequence of operations cannot be too greatly stressed.

6. The spreading of the tuberosities when single wire sutures are placed causes: (1) difficult approximation of the soft tissues, oftentimes necessitating the use of lateral incisions which are condemned; (2) mal-occlusion of teeth; (3) operations to lengthen the palate in order that perfect speech (which is the goal of the soft tissue operation) may be obtained.

7. Mere closure of the defect without anatomical and functional result is a poor substitute.

8. The employment of a pediatrician has accounted for a decrease in mortality.

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RADIUM IN THE TREATMENT OF CANCER OF THE VAGINA

IVAN DE BÜBEN, M.D., BUDAPEST, HUNGARY
Assistant Surgeon, First Gynecological Clinic, Royal Hungarian University, Prof. Joseph Frigyesi, Director

CANCER of the vagina is the most malignant and the most difficult to cure of cancers of the female genitalia. Fortunately primary vaginal cancer is rare, constituting but 2 per cent of the cancerous growths of the female genitalia. Secondary cancer of the vagina through extension from the surrounding organs is more frequent. It is almost impossible to distinguish the primary vaginal from the secondary growth, especially in advanced cases. Generally speaking, when the surrounding organs are free of cancerous growths but the vagina is involved, we can regard the case as a primary disease; in advanced cases the local extent of the growth serves us as a guide.

In our clinic in the 10 years between 1919 and 1929, of the 29 cases of primary vaginal cancer observed, 28 were treated with radiotherapy. This fairly large series of cases together with the fact that these patients were closely observed and supervised is the basis for the report of my experiences with radiotherapy in the treatment of this disease.

The patients are usually women past the climacteric; at a younger age cancer of the vagina is quite rare, although our youngest patient was 27 years of age, our oldest 71. As to the etiology, as in other cancerous growths we know little. It is hard to correlate its frequency with the number of births and abortions, as many patients observed were nulliparæ and uniparæ. In our series there were 4 nulliparæ, 6 uniparæ, and 19 multiparæ. Leucoplakia may be considered as a favorable soil for cancer; many regard it as a precancerous stage. Prolapse, prolonged irritation by a pessary, and cicatrices may help to produce cancer, but they cannot be regarded as the prime factors in causing the growth.

In the majority of cases the growth is located in the upper third of the posterior vaginal wall, this place being most exposed to traumata. It may also be located in the anterior or lateral vaginal walls. In our material the growth was located in 20 cases in the posterior, in 5 cases in the anterior, and in 4 cases in the lateral vaginal wall. There are two different types of vaginal cancer. The more frequent is a circumscribed tumor. In such cases the growth stands out like a mushroom, first with circular borders which become wider and wider extending into the slightly inflamed surrounding tissue and soon becoming ulcerated forming a small crateriform excavation that is covered with yellowish putrid slough and bleeds freely on contact. The rarer type is the infiltrating growth which permeates between the many layers of the squamous epithelium. In this type usually the vagina becomes a rigid tube.

Histologically vaginal cancer presents the appearance of either a squamous celled cancer or, exceptionally, an adenocarcinoma. In all of our cases we found the squamous celled cancer, never adenocarcinoma. Vaginal cancer proliferates rapidly toward the perivaginal connective tissues and the surrounding organs—the rectum, the bladder, the cervix, and the parametrium. As the most frequent location of the growth is the posterior vaginal wall, the rectum is most exposed to metastasis, and when the anterior rectal wall becomes involved there is established a rectovaginal fistula with an uneven, infiltrated border. The bladder is not so often affected by metastasis. In the connective tissue the growth progress is unimpeded and follows no definite order. The spread of the cancer is aided mainly by the vaginal lymph vessels; through these it passes rapidly to the lymphatic glands, and there depending on the location of the primary growth metastases are formed in the inguinal glands if the lower third of the vagina is involved; in the hypogastric iliac as well as the sacral and rectovaginal perirectal glands when the upper two thirds is involved. Metastases to remote organs are not frequent.

The symptoms are similar to those of cancer of the cervix. At first there is a discharge, usually tinted by blood, next a hæmorrhage which often is produced by coitus or vaginal douche. Pains appear late and indicate that the connective tissue has become involved in some extent. It is due to this absence of pains and disturbances in the early stages that patients come under observation only in advanced stages. Vaginal cancer grows rather rapidly and pregnancy favors its development. In the more advanced stages, when the rectum and bladder are also affected, tenesmus, obstipation, disturbances of micturition, and the appearances of fistulæ will be the symptoms. When the pelvic bones become infiltrated the pains will increase. The general symptoms of the disease are loss of appetite, anæmia, and finally general cachexia.

As the general appearance of the vagina in the presence of cancer is very similar to that of senile

vaginitis, sarcoma, tuberculous ulcer, hard ulcer, and decubitus caused by pessary or foreign body, an excision and histological examination is absolutely essential in making a differential diagnosis.

The prognosis offers less hope than in cancer of any other of the female genitalia. The location of the growth, the complex lymphatic system of the vagina, the thin vaginal wall which scarcely protects its delicate surroundings, together with the fact that most of the cases come under observation only in the advanced stages, all contribute to the impairment of the prognosis.

In the treatment, surgery and radiotherapy may be practiced, but because of the nature of the tissue involved neither offers much hope, and the results are therefore unsatisfactory. The formerly used methods, excision of the affected portions, proved entirely unsatisfactory. Only the most radical operation may bring results. The radical operation aims at total extirpation of the entire genital tract and several different methods may be mentioned. Wertheim advises the abdominal, Schauta the vaginal, Olshausen the perineal, Fritsch and Kelly the sacral approach. If the cancer is in the upper third of the posterior vaginal wall, Kroenig believes that the rectum also should be resected. Combined and modified dorsoperineal extirpations were performed among others by Paunz, Pozsonyi, and Kubinyi. When the cancer is in the upper third of the posterior vaginal wall, Frigyesi combines total extirpation with resection of the rectum, preserving the sphincter function. If the cancer is in an incipient stage and the patient's general condition is good, removal is usually possible. It is unfortunate, however, that more than 50 per cent of cases come under observation when the cancer has reached so advanced a stage that radical operation is generally impracticable. Even after the most radical operations the results are bad; in addition to the high primary postoperative mortality in many instances, there is, after a short interval, recurrence in 90 per cent of the cases. Although cures have followed operation in a few cases, still the situation as to recovery from operation did not improve with the introduction of radical operation.

In our department 28 of the 29 cases observed were treated with radiotherapy, only one being operated upon. The patient, 40 years old, was found to have a hæmorrhagic, uneven, flat induration the size of a golf ball, in the posterior vaginal wall. The histological examination showed squamous celled cancer. Kubinyi performed a total extirpation according to the method of Kraske and Paunz. The patient died 3 months after the operation. Section showed recurrence and metastases to the lymphatic glands.

Because of the difficulties and the poor results following the operative treatment of vaginal cancer, radiotherapy was greeted with hopeful expectations. Treatment with radium in the beginning in spite of the difficulties of its administration, proved very promising and the first observations apparently corroborated the favorable expectations. These great hopes were dampened, however, by statistics based on the 5 years' freedom from recurrence which is necessary to determine the efficacy of a method. A study of these proportionately few cases has shown that the improvement after radiotherapy is only transitory and that only in a small percentage is the prognosis improved.

The use of radium and the X-ray combined seems to be the most advisable means of treatment, that is, the growth is irradiated locally with radium, while the infiltrated lymphatic glands are exposed to the X-rays. Many difficulties are associated with the use of radium; for instance, the growth extends quickly through the thin vaginal walls and an uncautious application of radium only stimulates the formation of rectal or vesical fistulæ. The radium tube must be kept at a proper distance from the rectum and bladder, and care must be taken that the tube is properly fastened in the vagina. To avoid complications, the ray dosage must be determined with great care. Usually only small doses should be administered. To overcome the difficulties in the application of the radium tubes, many appliances have been constructed. The solid rubber pessaries made of different sizes and with small compartments for the radium tubes are the most practicable. These pessaries assure the proper distance between the tubes and the vaginal walls for the entire treatment of growths in any part of the vagina. Another means of application which has proved very suitable in many cases is a holder which is made of some moldable material shaped to the size and form of the vagina, which is provided with a thin rubber covering, and in which the radium tubes are embedded at proper places. This holder is placed in the vagina so that the radium tubes come exactly over the growths and it is fastened with silk ligature or plugging. Several other methods have been formulated to place the radium at the proper distance and to fasten the tubes in proper position.

In the tumorous type of vaginal cancer without involvement of the rectum or bladder, the implantation method may be used. Needles, small tubes, or thorium-X sticks may be used. The

implantation method should be used only with the utmost care in cases properly selected. It should not be used in the infiltrated type of the disease. In such cases only tubes should be used.

X-ray treatment alone is not sufficient. The X-ray should be used only for the lymphatic glands. For the local treatment of the growth, radium should be used. In institutes with large quantities of radium the glands are exposed to radium-tele-irradiation. After the surgical removal of vaginal cancer, radiotherapy is advisable as a prophylactic measure.

As cancer of the vagina is a rare disease, we have not sufficient data on which to base a final opinion as to the value of radiotherapy. Therefore our opinion must be based not on our experiences alone, but upon the few reports in the medical literature.

Cancers of the vagina are exposed to a single ray dose of radium of 1,200 to 2,400 milligram element hours. If the control examination shows an unsatisfactory result after 6 to 8 weeks, the treatment is repeated according to the result obtained. The lymphatic glands are treated with X-rays. Patients treated with radiotherapy are examined once every 6 weeks for a while, then once every 3 months and later once every 6 months; those who do not present themselves for the control examinations are followed up by letters from time to time.

The results obtained in our cases most of which were observed in the advanced stages correspond to the results obtained by others as reported in the medical literature.

In the years 1919 to 1929 the First Gynecological Clinic of the Budapest University treated 28 cases of primary vaginal cancer with combined radium and X-ray therapy. Of these 28 patients, 9 are still living: 1 after 9 years, 1 after 6, 1 after 4, 1 after 2, and 5 after less than 2 years. Of these, 2 patients can be regarded as cured; 1 free from recurrence after 9 years and the other after 6 years. Two lived 3 years, 1 lived 2, and 3 lived 1 year after the treatment; 12 died within the first year. One did not answer our repeated inquiries.

Of the 10 patients treated with radiotherapy by Gal at the Second Gynecological Clinic, 2 were free from recurrence for more than 5 years.

Of the 22 cases of Bumm treated with radium irradiation and observed for 3 to 6 years, 5 were successful. Adding these and Schaefer's cases to the cases treated at the Berlin Gynecological Clinic, in 1926 Philipp and Gonick reported 53 cases of vaginal cancer treated partly with radium, partly with combined radiotherapy. Of these 7 (13.2 per cent) were free from recurrence for more than 5 years.

Giesecke, of the Gynecological Clinic of Kiel, reported 3 cures in the 22 cases of vaginal cancer treated with radiotherapy.

Heyman reports 2 recoveries in 16 patients treated with radium at the Royal Radium Institute of Stockholm.

Similar results were obtained by Bagg, Bayley, Cahen, Delporte, Franqué, Ikeda, Lehocky-Semmelweis, Polubinsky, Starry, and Warnekros.

The results obtained in the treatment of cancer of the vagina, whether by operation or by radiotherapy, are still far from satisfactory. The advantage of radiotherapy over surgery is that radiotherapy has a wider range of applicability also that at least temporarily its effect is palliative in most of the cases. The Wertheim method in patients who can be operated upon or total extirpation combined with the resection of rectum in cases with the growth in the posterior vaginal wall are considered to result in recovery most often. However, as in most of the cases of cancer of the vagina, radiotherapy is indispensable, it is reasonable to hope, that by perfecting the methods of treatment and the application of radium the results will not only be improved but the risk of recurrence will decrease.

INFILTRATION ANÆSTHESIA AND ITS USE IN FRACTURES

CARL O. RICE, M.D., MINNEAPOLIS, MINNESOTA
From the Department of Surgery, University of Minnesota

ALTHOUGH the use of local anæsthesia in fractures had its origin in 1885 when Conway employed the method by injecting cocaine directly into the fracture gap, it has not become popular until recent years. It has been used by others more or less sporadically and only in a few cases. Among those pioneers are Reclus, Quenu, Braun (4), Dollinger, W. W. Jackson, Farr, Cumston, Fulton, Hagenbeck, Frostell, and Ira Cohen.

The prevailing opinion seems to have been that any injection into a broken bone or injured joint would be extremely likely to initiate an infection. But this erroneous idea has no sound basis if aseptic technique has been employed. Although he had not used it extensively in fractures, Braun (3) states that there should be no more reason for not injecting local anæsthesia into a fracture gap than in any other portion of the body. He was of the opinion that the danger from infection was very remote.

Nerve conduction anæsthesia for a fracture of the extremity was generally accepted with less skepticism and was employed to advantage by Keppler, Kulenkampff, Mueller, Mage, and Farr. But the skill required to produce nerve conduction anæsthesia usually prevents the general practitioner from employing this method very extensively. The inaccessibility of nerve trunks in certain areas, as in the hip, the shoulder, and the clavicle also make nerve block anæsthesia less desirable.

INDICATION

The only contra-indications to the use of local infiltration in fractures is the presence of an infection or a compound fracture. There may be other fractures where the use of local anæsthesia is not practicable, as in a fracture of the pelvis or a fracture of the spine, but these are not contra-indications for its use.

Relief of pain and relaxation of the muscles are the two main features to be accomplished with anæsthesia. The pain in a fracture arises largely from the torn periosteum and endosteum at the fracture gap. Surrounding muscles and muscle attachments are, no doubt, bruised and torn during the production of a fracture and thus cause pain. Allen states that bone and cartilage have no sensation but that the periosteum, endosteum, and synovial membrane are almost as sensitive as the skin. He states that the bone marrow is also slightly sensitive.

With the employment of a general anæsthetic relaxation is not complete unless it is brought to the stage of surgical anæsthesia. This is sometimes difficult to accomplish with the administration of nitrous oxide or ethylene. On the other hand, relaxation of the muscles is possible under the influence of local anæsthesia, and this relaxation may be as satisfactory as under deep surgical anæsthesia. I have used procaine hydrochloride in an intracapsular fracture of the hip with relaxation so complete as to permit overcorrection of the fragments where under gas anæsthesia undercorrection is almost always the rule (Fig. 6).

It has been well expressed by Arthur E. Hertzler that "the difficulty encountered in the reduction of fractures is due to the muscle spasm produced reflexly by the injured tissues and when the damaged area is anæsthetized the spasm subsides." He considered it important to anæsthetize the periosteum at all points.

If a fracture is treated as an emergency as should be done, the anæsthesia will be more effective in producing relief of pain and relaxation of the muscles, for at this time the surrounding tissues will not have become so swollen and tender and the greater pain will be complained of at the site of the fracture gap. If the fracture has persisted for several days it may be necessary to infiltrate some of the surrounding tissues and painful points before the effect of the anæsthetic will be complete. I have seen cases in which the fracture has been present for several days, immobilized in a pillow splint without reduction, supposedly waiting for the swelling to subside. In these cases the forearm or leg (as the case may be) is usually very markedly swollen from the finger tips to the elbow. The entire injured extremity is tender not so much as a direct result of the fracture but because of the swelling and œdema of the surrounding tissues.

These cases usually do not demonstrate the best results from the local infiltration, and it is evidently impossible to infiltrate the entire extremity with novocain. Supplementary medication with morphine or scopolamine in these cases is efficacious for it is usually these cases which require repeated trials at reduction and the aid of the fluoroscope. The anæsthetic effect begins within 5 minutes and is prolonged for at least one hour.

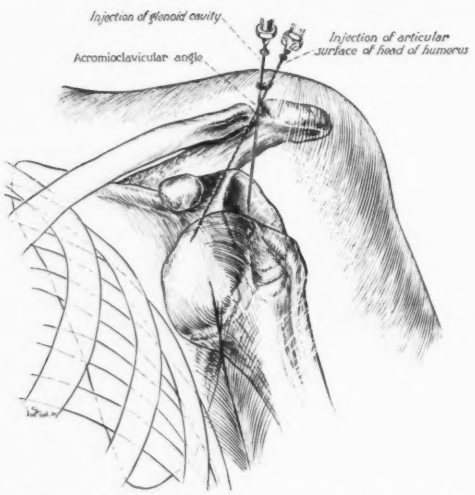

Fig. 1. Indicating the approach to the shoulder joint.

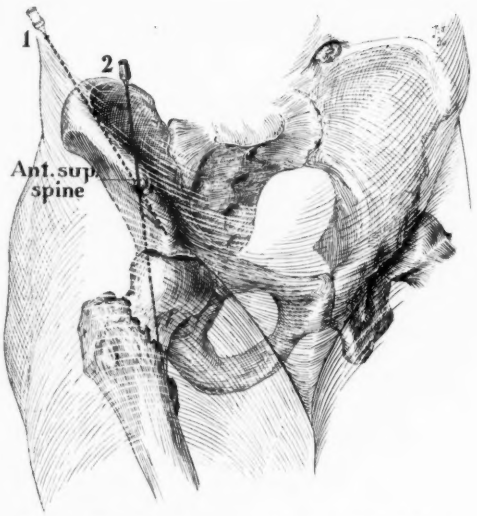

Fig. 2. Showing the approach to the hip joint for fractures of the hip.

This allows sufficient time for X-ray examination after reduction, and remanipulation if necessary.

Boehler has employed local infiltration in fractures for several years. He has used it in more than 2,000 cases with satisfactory results and without complications. No case of infection as a result of this procedure has been reported. No case of delayed healing has been attributable to this method of anæsthesia. The theoretical production of a compound fracture by this method reduces itself to obscurity if ordinary aseptic precautions are observed.

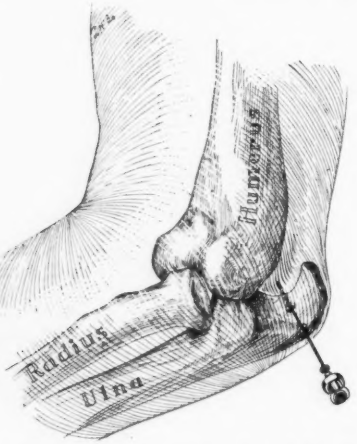

Fig. 3. The approach to a dislocation of the elbow or fracture of the olecranon.

PROCEDURE

It is noteworthy that no meticulous detail of technique is necessary in order to produce perfect anæsthesia with this method. Infiltration into the fracture gap so that the torn edges of the periosteum and endosteum become impregnated with the anæsthetic solution is usually all that is necessary to obtain local analgesia. Infiltration of the periosteum about the proximal fragment is not usually necessary as has been suggested in an earlier article (23). It will, however, aid in those cases which have been delayed for several days.

The skin over the fracture is cleansed, then sterilized with iodine and alcohol and draped with sterile towels. A 1 per cent solution of procaine hydrochloride with 4 drops of adrenalin per ounce is used. The initial subcutaneous wheal is made directly over the fracture gap with a fine gauge hypodermic needle so as to minimize the pain as much as possible. This is then substituted by a longer fine gauge needle. Infiltration of the tissues is made slowly ahead of the needle, as it progresses to the fracture gap so as to alleviate the pain during the process of infiltration. The needle is not withdrawn until the infiltration is complete thus avoiding the possibility of contamination from repeated punctures. If the syringe must be refilled it is removed, leaving the needle in place.

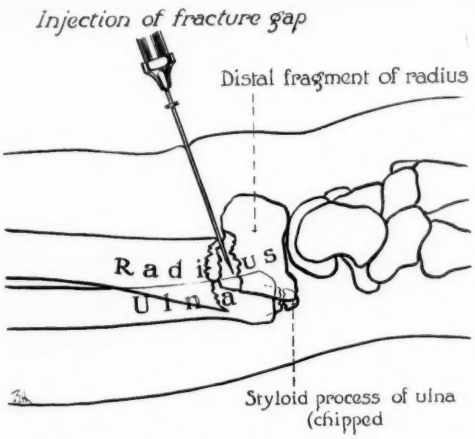

Fig. 4. Injection of fracture gap. The needle enters the fracture gap and bloody fluid can always be aspirated.

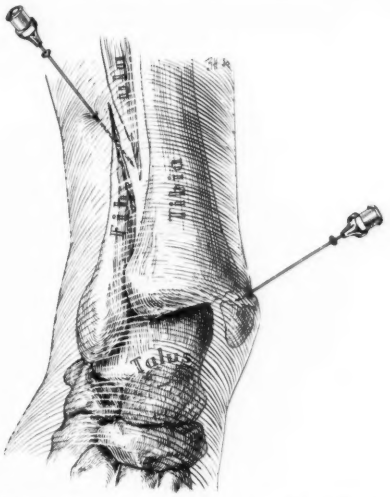

Fig. 5. The injection of a fracture of the ankle.

When the fracture gap is entered, the required amount of procaine is injected. The position of the needle within the fracture gap can be identified by the ability to aspirate bloody fluid into the syringe. This blood has a cloudy appearance in contradistinction to arterial or venous blood, and does not indicate that novocain is being injected into the blood stream. It has always been possible to aspirate blood. This has been used as a criteria for determining the position of the needle within the fracture gap or in direct communication with it. No evidence of procaine poisoning has ever been observed. From 10 to 60 cubic centimeters may be required depending upon the size of the bone and the extensiveness of the injured tissue.

In previous papers (24, 25) certain points of entrance into the fracture or dislocation have been designated largely for the sake of convenience. These designations are arbitrary and have no direct bearing upon the result of the anæsthesia.

For a dislocation of the shoulder or fracture of the neck of the humerus, the approach is made through a puncture at the anterior edge of the acromio-clavicular articulation, directing the needle very slightly medially and posteriorly so as to enter the joint capsule and the glenoid fossa; also rerouting the needle and directing it slightly anteriorly and medially to the disarticulated head still within the joint capsule (Fig. 1). By using this fixed landmark the distortion of the shoulder will not lead one to an erroneous infiltration. Twenty cubic centimeters of procaine hydrochloride within the joint capsule should be sufficient to produce anæsthesia.

In an intracapsular fracture of the hip or dislocation the approach is made through a puncture

Fig. 6. Fracture of the femur showing over correction. This was purposely done before the cast was completely fixed, to indicate the relaxation which is possible under local anæsthesia.

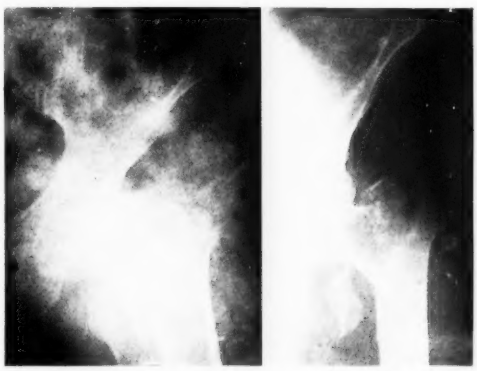

Fig. 7. Fracture of the hip reduced under local anæsthesia. Before and after reduction.

at the lateral border of the anterior superior spine of the ilium (Fig. 2). The needle is directed inward and slightly backward so as to pass along the lateral surface of the ilium over the brim of the acetabulum and into the joint capsule. This approach avoids important nerves or blood vessels and directs one accurately into the fracture gap regardless of the distortion of other landmarks. The anæsthetic solution diffuses into the fracture gap. Twenty cubic centimeters of procaine hydrochloride directly into the joint capsule usually suffices.

In a dislocation of the elbow the needle is inserted into the joint space from the lateral surface at the border of the palpable olecranon fossa (Fig. 3).

For any of the superficial fractures where the bone ends are easily palpated as in a Colles' or Pott's fracture or a fracture of the clavicle or phalanges, the needle is inserted directly into the fracture gap at its most superficial point. The anæsthetic solution will readily diffuse throughout the entire fracture. Gentle manipulation may facilitate this diffusion (Figs. 4 and 5).

In a series of more than 200 cases observed or personally attended, I have seen no complications or sequelæ as a result of this method. One child, 7 years of age, refused to co-operate during the manipulation but was quieted immediately after the administration of a few breaths of nitrous oxide. A few others have been observed in whom the swelling and tenderness of the muscles failed to permit relaxation, but all these cases have been observed in unreduced fractures of more than 2 or 3 days' duration. I have used it in 10 intracapsular fractures of the hip with good results. In some of these cases, soreness was observed along the thigh during the manipulation, but never sufficient to require general anæsthesia. Relaxation was always satisfactory.

SUMMARY

There are no untoward effects from the use of local anæsthesia in fractures. The simplicity of this method of anæsthesia makes it especially desirable. Better alignment of the bones can be accomplished because the fracture can be reduced with the aid of the fluoroscope if necessary and repeated adjustments may be made without further inconvenience to the patient. Relaxation of the muscles is accomplished satisfactorily. It does not interfere with the healing of fractures.

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HERNIOPLASTY—WATER INJECTION OF THE SAC TO FACILITATE ITS REMOVAL

SAMUEL ROBINSON, M.D., F.A.C.S., SANTA BARBARA, CALIFORNIA
From the Clinic of the Santa Barbara Cottage Hospital

IN the process of indirect inguinal hernia repair, the isolation of the sac and its separation from the cord is not infrequently an awkward performance. The cleavage is not a true one, the dissection is artificial, small veins are generally ruptured, an otherwise clean dry field becomes a wet one, the field is often "painted red," the tissues are less easily differentiated, trauma to the cord and injury to the vessels results not infrequently in swelling of the testicle and scrotum.

For the past 10 years the writer has employed a method of isolating the sac which is illustrated in the drawings (Figs. 1, 2, 3). It is applicable only to reducible, indirect, inguinal hernias, complete or incomplete. It is not applicable in the removal of sacs less than 5 or 6 centimeters in length. Obviously it should not be employed if there is any indication of adherent bowel or omentum within the sac.

The cord is delivered in the usual way from the inguinal canal. A thin rubber tourniquet is applied with a single knot around the cord and neck of the sac at the internal ring. The Penrose drainage tubing is particularly suitable for the purpose (Fig. 1). It has never produced any evidence of trauma to the cord structures. It should be tight enough to retain the sterile water later

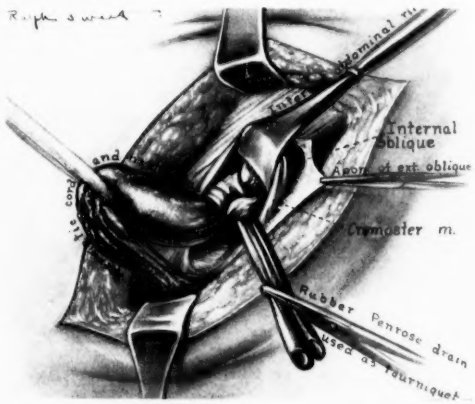

Fig. 1. The spermatic cord with the attached hernia sac is delivered from the inguinal canal. A Penrose drain is placed as a tourniquet around the cord and the neck of the sac at the internal ring.

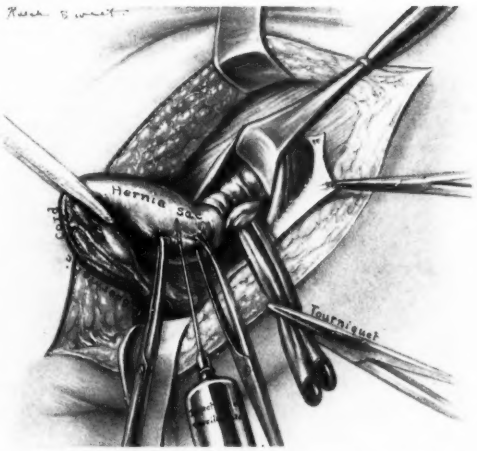

Fig. 2. The side of the sac is picked up with Allis forceps. A syringe needle is inserted into the sac and sterile water is injected.

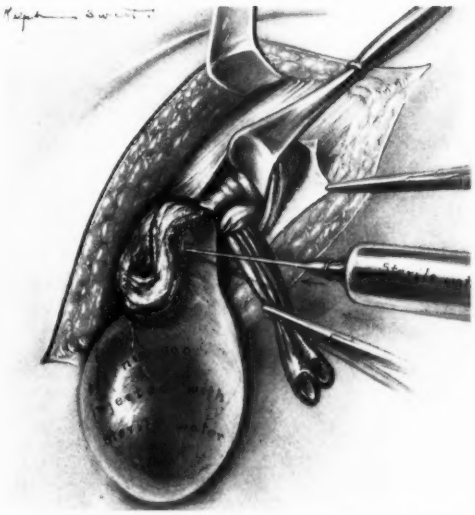

Fig. 3. The sac is completely distended by the injection of water. In the distended state the sac has been dissected from the cord.

injected into the sac; not that any leakage into the peritoneal cavity is of any significance, but that such leakage prevents sufficient distention of the sac to facilitate the dissection.

On the posterior internal aspect of the cord it is not difficult to recognize the smooth, white tissue of the hernia sac. It should be picked up with thin bites of the two Allis forceps (Fig. 2). The syringe needle inserted into the sac between the forceps should not penetrate more than a few millimeters while the injection is started. If the sac is entered properly it will gradually distend under the pressure of the entering fluid. If the needle point is not accurately within the lumen of the sac an infiltration of the surrounding tissue will follow. This error is disclosed by the absence of an air bubble which is generally visible when the water is properly injected into the sac. The mistake is rarely made if the walls of the sac are well elevated before the needle is introduced. As the fluid enters the sac the forceps are removed, the needle is inserted to a more secure depth, and is held in position by the thumb and forefinger thus preventing leakage around the needle. The injection should be carried on until the sac is distinctly tense; the greater the distention the easier the dissection. The needle is then withdrawn, a hæmostat being applied to the point of puncture. The separation of the sac from the cord by scissor-spreading dissection then becomes a simple and satisfactory procedure without bleeding. The fundus is clearly defined; in cases of congenital hernia the relation of the sac is emphasized.

After the distended sac has been isolated completely from the fundus to the neck (Fig. 3), it is opened wide at the fundus, the water emptying into a basin. The tourniquet is removed, the sac transfixed and amputated, and the hernia repair continued.

Although it is the writer's impression that this technical point in hernioplasty has not previously been described, his apologies are nevertheless tendered herewith to anyone who may have done so.

SKELETAL DISTRACTION

Description of Apparatus

DAVID M. BOSWORTH, M.D., New York

THE literature is rather scant regarding the problem of the shortened extremity and more than scant regarding the lengthening of the offending bone or bones and soft structures. Refracture and manipulation of malunited bones to overcome shortening has been an inherited procedure attempted by many and successfully accomplished by few. A few millimeters occasionally have been gained but a return to normal length has rarely, if ever, been secured.

About 1905, however, Codivilla devised and advocated the use of skeletal traction as an answer to this problem, and so it has proved to be. Perhaps I should say he advocated skeletal fixation, for his calcaneal pin was to be used only to maintain length gained at the time of operation, and not to secure further extension. To quote him: "I am convinced that in the extension of fleshy parts the best results are obtained from forced lengthening by using sudden and intense force and then applying plaster." In other words, he divided the bones, applied extreme force until no further length was gained, and then applied a plaster spica with steel side-pieces to maintain the calcaneal pin in extension. This process was repeated several times if necessary, about 3/8 inch being gained each time. Freiberg reviewed Codivilla's work and again advocated his methods in 1912.

Magnuson, in 1908, 1911, and 1913, attacked this problem and advocated the division of the short bone, with immediate traction through hooks inserted in the cut bone ends, and the securing of the bone ends in the extended position by bone and ivory nails and screws. It is noteworthy that in these same articles he records the result of excellent work on the changes in, and absorption of, the inserted materials. The amount of extension gained remained about the same as that of Codivilla and Freiberg.

Taylor, in an article written in 1918, entitled "Shortening Long Legs and Lengthening Short Legs; a New Surgical Procedure" reported lengthening by the use of skin traction, with subsequent pinning of the bone fragments with tibial bone pegs. The greatest length secured by him was 2 centimeters. He advocated removal of a segment from the bone of the opposite side either in combination with the above or as supplementary to it. Numerous workers have concurred with him in that the simplest procedure, heretofore, was to shorten the long extremity, among them Fassett. The latter also attempted lengthening the short bone, inserting blocks of magnesium or ivory between the separated bone ends to maintain extension. Skin traction also seems to have been used by him.

Putti, in an article published in Surgery, Gynecology and Obstetrics in 1912, first brought forth the principle of distraction. Traction implies the application of one force to the distal fragment of the bone to be lengthened and the opposing force indirectly upon the body or through the structures attached to the proximal fragment. Distraction implies the direct application of the separating forces to the two fragments of bone to be lengthened. His device, called the osteoton, consisted of a single extension member acting on pins driven into the bone fragments on both sides of a Z shaped osteotomy. His work was on the femur only and the results were extremely satisfactory, gains of 2 to 4 inches being secured. Others, working with his apparatus, have been unable to maintain the pins in place due to the action of the single extension member.

The operative lengthening of the long bones of the body was first placed on a uniformly successful basis in 1927, when Dr. Abbott, of St. Louis, presented an apparatus devised by himself and reported several cases of tibial lengthening. His article demonstrated beyond doubt that added length could be gained surely, safely, and easily. In this article he re-emphasized the principle I have called distraction and added a second extensive member to Putti's apparatus, thus obviating the slipping of the skeletal pins which had been so troublesome. He also emphasized the use of moderate, continuous force over a considerable period of time and the division of resistant unimportant soft tissue structures.

Since that time the literature on the subject is practically limited to an article by White, of South Carolina. In this Dr. White advocates the insertion of two pins above the area of tibia to be divided and two below; the division of the tibia in the usual tongue and groove or similar fashion; the application of a cast to include the

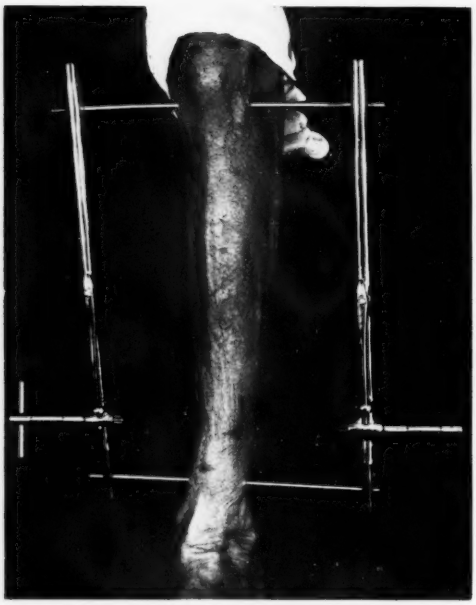

Fig. 1. The present apparatus as applied by the two pin method to W. B., the first case herein reported.

pins; circular division of the cast opposite the area of proposed tibial lengthening; and distraction of the two halves of the cast, with their included pins and tibial fragments, by means of turnbuckles whose ends have been incorporated in the cast.

I feel that some space should be devoted at this place to the description of Dr. Abbott's apparatus, for the principles used by myself are his, and the apparatus herein presented differs from his original apparatus only in the method of securing extension and the greater ease of manufacture. Since this article in 1927, further refinements have been developed in the apparatus used at his clinic, until now, for simple operative lengthening of the tibia it supersedes both his original apparatus and that herein presented. For other uses, however, where distraction is necessary, as in the maintenance of a fracture, such as is shown later, the present apparatus is ideal.

The original Abbott apparatus consisted of two tubular sidebars with transverse holes in their ends which were slipped over pins driven through the extremities of the bones to be lengthened. Each sidebar was composed of a tube, into which fitted a rod. A cuff fastened about midway on the

Fig. 2. The apparatus herein presented disassembled, showing the tibial pins, the drill used, and the two sections of the Taylor hip traction splint drilled at one half inch intervals and used to secure extension.

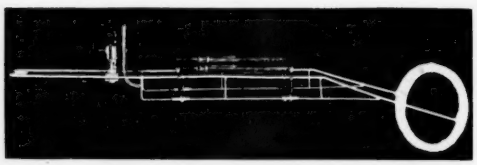

Fig. 3. The special Thomas splint with turnbuckles from the lower rods to the pins for varying the position of the extensive apparatus and the relation of the fragments. Adjustable footpiece shown.

rod permitted the thrust of a coiled spring which could be compressed by a collar threaded on the tubular element. Rotation of the fragments could not be controlled by the apparatus *per se*, but was prevented by turnbuckles extending between a specially devised Thomas splint and the ends of the tibial pins.

In order to prevent this possibility of rotation, and to obviate the expense of a specially constructed apparatus, two sections were cut from the extensive portion of two old Taylor traction hip splints. Three sixteenth inch holes were drilled in the ends at half inch intervals. These were then substituted for the side pieces of Abbott. Ordinary drill steel, 3/16 inch in diameter, was cut into pins 9 inches long and the ends rounded. These pins provide the spring action given by the coil springs of Abbott. They bend as the extensive force is increased and spring back as the soft structures give. Rustless steel has recently been used for these pins. A hand drill and a long 3/16 inch steel drill complete the extraneous equipment (Fig. 2).

The operative procedure used in the uncomplicated case of bone lengthening would not be varied from that described by Abbott. It consists in: (1) Lengthening the Achilles tendon, (2) insertion of the pins, (3) osteotomy of the tibia and fibula, (4) application of the apparatus.

The usual pre-operative preparation of the skin for bone cases is carried out. The tendon length-

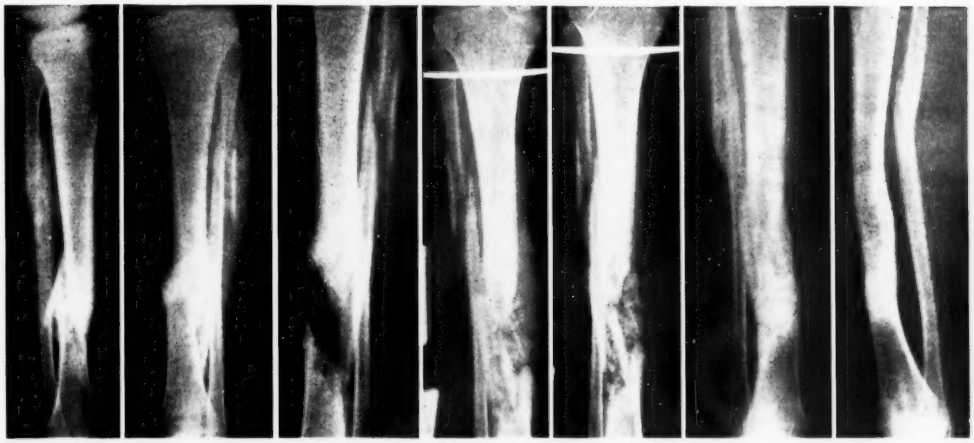

Fig. 4. Fig. 5. Fig. 6. Fig. 7. Fig. 8.

Fig. 4. W. B. X-ray pictures of the original condition with 1⅝ inches shortening and solid union.

Fig. 5. W. B. X-ray picture showing practically full lengthening and gap between bone ends.

Fig. 6. W. B. X-ray picture showing maintenance of extension by one large bone chip and the presence of several smaller ones.

Fig. 7. W. B. X-ray picture showing absorption taking place in bone chips prior to recalcification and ossification. Compare with Figure 6.

Fig. 8. W. B. X-ray pictures showing condition one year after the first operation, with reappearance of medullary cavity. Slight anterior bowing present by X-ray, barely noticeable clinically.

ening is done by the standard method of inverted L incisions, the cuts being directed either sagitally or transversely, so that continuity of tendon tissue is not lost, and then the tendon is lengthened an amount to correspond with the expected lengthening of the tibia. In inserting the tibial pins the steel drill is first passed through a hole in one of the side extension bars and then through a stab incision on the medial side of the leg at, or distal to, the tibial tuberosity. The skin should be retracted toward the center of the tibial shaft in making the stab incisions and drilling the holes to lessen the tension on them as the tibia is lengthened and the skin slides over the bone. The direction of the hole drilled in the tibia can then be controlled by the position of the sidebar. After the hole is drilled, a pin is inserted and the sidebar placed on the pin. Further holes in the distal end of the tibia and a second one in the proximal end may be drilled through the holes in the sidebar, using this as a guide to maintain their alignment. The sidebars are then placed on the pins. Through a single, long, curved anterolateral incision the midportion of the tibia is exposed. With motor saw, parallel vertical cuts are made on either side of the tibial crest, the saw scarfs slanting inward and backward. These cuts are joined below anteriorly and above posteriorly, providing a tongue and groove osteotomy. The crural fascia may be widely incised if necessary. After the wound is closed, vaseline gauze dressings are applied to the incision area around the pins. A tissue drain should be used for 48 hours.

Two, three, or four pins may be used at any desired interval, thus preventing anterior or posterior displacement of the fragments. Rotation is prevented by the construction of the sections of hip splints used for side extension bars. Lateral displacement is prevented by the transverse direction of the pins. The special Thomas splint with turnbuckles originally used to keep alignment and prevent anteroposterior displacement (Fig. 3) may be discarded when three or four pins are used. If three pins are used, two should be in the proximal fragment and one in the distal. The distal fragment can then be controlled by varying the counterweight used to prevent the foot drop. The apparatus and leg may be suspended from a Bradford frame through cords attached to the pin ends. Foot drop is prevented by the foot piece on the special Thomas splint or by a counterweight attached to the Bradford frame.

Except where the apparatus is used in a fresh fracture, less than ⅜ inch lengthening will be gained at the time of operation. Extension of ⅛ inch every second day will be about the average

Fig. 9. Fig. 10. Fig. 11.

Fig. 9. J. B. Pre-operative roentgenogram.
Fig. 10. Apparatus as applied to J. B. Note that alignment is maintained, rotation prevented, and the weight of the leg sustained without other appliances.
Fig. 11. J. B. Postoperative roentgenogram.

increase practically independent of the force applied, so that the side arms of the apparatus may be extended one notch on alternate days. Personally it would seem best that pin dressings be not changed until the pins were to be removed. The patient experiences practically no discomfort from the lengthening once the postoperative pain is gone.

CASE REPORTS

CASE 1. W. B., a young man, aged 22 years, was seen in my office January 8, 1929, with the left tibia and fibula short 1⅝ inches and solidly united following a fracture 5 months before. Due to the condition present the usual tongue and groove method of tibial lengthening was impossible but operative lengthening was advised (Fig. 4).

First operation. January 9, 1929, through a long, curved anterolateral incision the left tibia and fibula were divided through the old fracture line and two pins were inserted, one through the tibial tuberosity and the other through the distal third of the tibial crest (Fig. 1). The apparatus reported above was applied and as only the two pin method was in use the appliance and extremity were put up in the modified Thomas splint. Less than ⅜ inch lengthening could be secured at the time of operation with the bone ends visualized. The Achilles tendon and crural fascia were not lengthened or divided as compensatory shortening had not taken place in the former, and the latter, we believed, would stretch. The incision was closed without drainage.

Postoperative course. The apparatus had been extended ⅜ inch January 9, and no further extension was made until January 15, when ⅛ inch extension was made. During the next 17 days the apparatus was extended 11 times, each time for ⅛ inch only. On February 1 the pins were markedly bowed but no further length was being obtained. X-ray examination showed that the fibular fracture site had united and was preventing further extension. The fibular fracture site was therefore manipulated to break up the callus formation. Following the manipulation the appliance was lengthened ⅛ inch on the morning, at noon, and on the afternoon of February 1, extension being easily gained. Late that evening measurements showed that the lengthening of the bones had proceeded ⅜ inch during the day. The pins were slightly bowed. No further extension of the appliance was made, yet due to the spring action of the steel pins, lengthening continued and we were surprised to find a full 2 inches had been gained by February 3 (Fig. 5).

Second operation. February 6, through a curved medial incision, the gap between the ends of the tibial fragments was exposed and several cubic centimeters of clear reddish fluid evacuated. Fibrin and new fibrous tissue was removed from the bone ends with a curet. A large chip of the original fracture was removed and wedged vertically into notches cut in the tibial fragments. Numerous bone chips were cut from the tibial fragments and thrown loosely into the space between them. The soft tissues were closed in layers, a silkworm gut drain being included in the center of the wound. The extension of the apparatus was then reduced ¼ inch, as only 1⅝ inches lengthening was desired.

Postoperative course. Slight swelling was present the first postoperative day but had disappeared by the third day (Fig. 6). The silkworm gut drain was removed on the fourth day. The sutures were removed and the wound found healed on the tenth day. March 13 the dressings about the pins were saturated with picric acid solution

for 10 minutes and then the pins were cut with sterile rivet shears beneath the dressings, and removed. At this time they had been in place for 9 weeks, yet on removal they were not found loosened, and the surrounding skin edges were clean and dry. No absorption could be made out in the pins themselves. The pin holes were closed and all crusts were off 21 days after the removal of the pins. Weightbearing without apparatus was permitted 6 months after the first operation and 1 year later the patient had no limp or foot deformity. There was slight anterior bowing of the bones of the leg as shown in Figure 7. Figure 7 compared with Figure 6 shows the decalcification which took place before the calcification and ossification commenced.

The only complication that arose was a small skin necrosis over the tuberosity of the os calcis which was easily closed with a pedicled full thickness graft from the opposite calf.

The following points are noteworthy in this case: The patient's age was 22 years, or several years older than any case reported in which the lengthening secured was comparable. The site of lengthening was at the point of junction of the distal third of the tibia with the proximal two thirds. This is the most frequent site for nonunion of fractures, yet development of callus and ossification proceeded rather rapidly. The tongue and groove method of lengthening was impossible, but the rather large gap created filled in readily. The marrow cavity has already markedly replaced the newly formed bridge of bone (Fig. 8). Union and full weightbearing without protective apparatus was possible in 6 months. Full length has been maintained.

CASE 2. J. B. was seen on the ward of Broad Street Hospital November 12, 1929, 12 hours after being crushed by a large boulder. Examination revealed multiple fracture sites, among them a compound comminuted fracture of the left tibia and fibula, 1¼ inches proximal to the ankle joint with over 2 inches' shortening and marked displacement (Fig. 9). The line of skin laceration over the anteromedial surface of the distal end of the tibia was 5½ inches long, exposing the underlying bone throughout. The accompanying fibular fracture was compounded through a second opening on the lateral side of the leg, as well as into the tibial wound. The left foot was cyanotic, cold, almost devoid of cutaneous sensory response, and tremendously swollen. Crepitation and abnormal mobility were present over the metatarsals, but due to the patient's condition no effort was made to secure an X-ray picture.

Operation. November 12, under light ether anæsthesia, a 3/16 inch hole was drilled through the neck of the left os calcis and a drill steel pin 9 inches long was driven into place. A similar pin was placed through the tibia just distal to the tuberosity. The side extension bars described above were placed on the ends of the pins and full extension to normal length easily secured (Fig. 10). Debridgment of the tibial fracture site was carried out and the laceration and fracture site packed widely open with vaseline gauze. Sterile dry dressings were applied.

Postoperative course. Before the patient left the operating room, the circulation in the foot had improved, a dusky red color obtained with the return of warmth to the skin. Portable X-rays taken the next day showed good alignment and extension (Fig. 11). On November 13 the patient was comfortable, with the leg and apparatus supported from a Bradford frame, allowing the patient free movement in bed, while retaining the leg fragments rigidly in position. The swelling of the foot was reduced 50 per cent and sensation and circulation were good. The condition of the tibial wound continued to improve in spite of the patient's general decline; the patient died of pneumonia 10 days after the injury. No autopsy was permitted but the pins were removed postmortem. No evidence of infection of the pin holes was found. They were so tightly seated they had to be driven out with a mallet.

It is unfortunate in reviewing the case that death occurred in the patient who might otherwise have obtained a good result insofar as the tibial fracture was concerned. The important point to bring out is that traction was imperative to save the foot. Skeletal traction was indispensable as skin traction could not be applied due to the distal location of the fracture and the already traumatized integument. Distraction by some device similar to that used was essential as the patient's position could not otherwise have been freely changed while the leg fragments were maintained in position. Had it been advisable, wet dressings or dakinization could have been carried out with the utmost facility, as the entire leg was readily accessible without the removal of the apparatus.

SUMMARY

An apparatus has been presented that is useful wherever skeletal distraction is indicated. It is simple, rigid, and easily made.

Two cases have been presented demonstrating the use of the appliance, where other methods would have been difficult or impossible.

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SPINAL ANÆSTHESIA IN ABDOMINAL SURGERY

LELAND S. McKITTRICK, M.D., F.A.C.S., WILLIAM L. McCLURE, M.D.,[1] AND RICHARD H. SWEET, M.D., BOSTON
From the East Surgical Service of the Massachusetts General Hospital

SATISFACTORY anæsthesia for a surgical operation within the abdomen requires a loss of the sensation of pain and sufficient muscular relaxation to permit the surgeon to perform the operation without loss of time and with a minimum of local trauma. If, in addition to this, the anæsthesia can be safely induced without distressing symptoms to the patient; is of sufficient duration; and the drug employed is not toxic or irritating to such important viscera as heart, lungs, or kidneys, that anæsthetic approaches the ideal. There is much in the literature of the past 3 years to make one feel that the injection of a proper solution of procaine hydrochloride into the subarachnoid space more nearly approximates this than any other anæsthesia.

This investigation was undertaken without prejudice in an earnest desire to ascertain how closely this type of anæsthesia approaches the ideal and what part it might be expected to play in the surgery of a large general hospital. There were at least four questions which we hoped to answer.

1. What are the indications and contraindications for its use?
2. What is the safest, easiest, and most dependable method of induction?
3. What are the advantages and disadvantages of this type of anæsthesia both to the patient and to the surgeon?
4. What is the effect of this type of anæsthesia upon postoperative complications?

METHOD OF STUDY

For the purposes of this study only cases are considered in which the area of anæsthesia extended to or above the level of the umbilicus. In order that there might be a minimum of discrimination in the selection of patients, spinal anæsthesia was made routine for all abdominal operations on the East Surgical Service of the Massachusetts General Hospital for patients 45 years of age or over. The period of study lasted for one year beginning October 1, 1928. There were, in addition, a number of patients in younger age groups in which spinal anæsthesia seemed desirable. With few exceptions all anæsthesias were administered by one of the authors. For purposes of control the West Surgical Service made no change in its routine nitrous oxide-ether sequence except in a relatively few cases where spinal anæsthesia or nitrous oxide and oxygen seemed definitely indicated.

The East and West Surgical Services are of similar size. During this period many of the patients from the two services convalesced in the same wards. Patients are admitted to either service through the admitting office or emergency ward without any discrimination, every effort being made on the part of hospital authorities to maintain the two services as much alike as possible.

For the collection of data a special anæsthesia card was used for each case. The data during operation were noted by a student anæsthetist and during the postoperative period by one of us.

STATISTICAL DATA

Age and sex. There were 415 cases in all, of which 215 (52 per cent) were male and 200 (48 per cent) were female. The distribution of cases as to age is shown in Table I.

TABLE I.—AGE BY DECADES

Years	Cases
1 to 9	0
10 to 19	11
20 to 29	45
30 to 39	67
40 to 49	92
50 to 59	106
60 to 69	73
70 to 79	20
80	1
Total	415

Types of operation. Operations for the repair of herniæ led the list with 78 cases. Most of the operative procedures, however, were

[1] Deceased.

within the abdomen; 9 other operations were included merely because the level of anæsthesia was high although the operations themselves were not abdominal (Table II).

TABLE II.—TYPES OF OPERATIONS IN ORDER OF FREQUENCY

	Cases
Repair of herniæ (all varieties)	78
Operations on gall bladder and bile ducts	60
Operations on colon and rectum	58
Operations on pelvic viscera (female)	57
Operations on stomach and duodenum	54
Appendectomies	47
Exploratory laparotomies	25
Operations on small intestine	15
Operations on lower extremities	9
Drainage of residual abscess (abdomen)	4
Splenectomies	3
Lumbar ganglionectomies	2
Operations on genito-urinary tract	2
Laminectomy	1
Total	415

PRE-OPERATIVE MEDICATION

Sufficient narcosis to relieve the patient of the mental strain of operation was deemed essential. The amount of medication necessary to obtain this is extremely variable, and there can be no dogmatic rule for either the kind or the amount of drug to be used. It was found that in young, healthy adults, satisfactory results usually were obtained with 1/6 grain morphine and 1/200 grain scopolamin given 1½ hours and again ½ hour before operation. In elderly or weak patients, smaller doses were sufficient. In many of these it was found best to omit the scopolamin because of its tendency to produce delirium, a small dose of morphine being enough. In others it was unnecessary to give preliminary medication, the slightly depressing effects of the anæsthesia itself being sufficient to carry them along satisfactorily. Rarely, if ever, ought morphine to be given on the operating table for restlessness or discomfort. If anæsthesia is not entirely satisfactory, some form of supplementary anæsthesia is necessary but additional morphine ought not to be given in its place.

Ephedrine sulphate, 50 milligrams, was given to each patient prior to the injection of the anæsthetic. In a few cases this was repeated during the course of operation if the blood pressure fell to a point where some type of stimulation seemed indicated.

METHODS OF INDUCTION OF ANÆSTHESIA

Spinocain (Metz) as introduced by Pitkin was used first. The solution with a specific gravity of 1.005 is lighter than spinal fluid (1.007) and because of this the level to which it rises within the spinal canal can be more or less controlled; due to its viscosity it is said to produce anæsthesia of longer duration and more uniform than is obtained from other solutions. Although every effort was made to follow the technique as outlined by Dr. Pitkin, there were occasional delays, and in one or two instances complete failure in obtaining a suitable level of anæsthesia. In one case there was complete absence of anæsthesia after two injections of the solution each containing 200 milligrams of procaine. Spinal fluid could be aspirated at the end of each injection, leaving little doubt but that the solution was put into the subarachnoid space. In view of the occasional uncertainty attending its use and the absence of sufficient compensating advantages, spinocain was used but 39 times in this series.[1]

The heavy (glucose) solution first used by Barker and later advocated by Hepburn was then used in a series of 116 cases. This solution was obtained by dissolving 400 milligrams of procaine crystals in 4 cubic centimeters of a solution of 5 per cent glucose in sterile saline. With the patient in the lateral position the puncture was made in the third or fourth lumbar interspace, and without withdrawing any spinal fluid, from 1 to 3 cubic centimeters of the solution (100 to 300 milligrams of procaine) were injected. Following this, the head of the table was lowered to produce an angle of about 30 degrees for not more than 20 seconds. The table was then made horizontal and the level of anæsthesia tested. If it was not high enough, the head of the table was lowered a second time and if necessary a third time in order to get a satisfactory level of anæsthesia. After the desired level was obtained, the patient was left in horizontal position with the head and shoulders slightly

[1] Spinocain had been used in the hospital about 2 months prior to the beginning of this series.

elevated on a pillow. Great caution is necessary in using this method to avoid keeping the head down too long because the solution is heavy and will travel rapidly. The results with this method were reliable and satisfactory. It has nevertheless definite theoretical disadvantages. It involves the use of a glucose solution, the purity and sterility of which must be controlled. Furthermore the patient cannot be put into Trendelenburg position for at least 20 minutes after the induction of anæsthesia.

The method finally adopted was the injection of a solution of procaine hydrochloride in the patient's spinal fluid, modified somewhat from the technique described by Labat. This method, described in detail below, proved most satisfactory because of its simplicity, safety, and uniformly good results.

The technique finally adopted is as follows:

Materials

1. No. 20 or No. 22 gauge, short-beveled, flexible, lumbar puncture needle.
2. Small hypodermic needle.
3. One 5 cubic centimeters and one 2 cubic centimeters glass syringe.
4. Sterile water.
5. Sterilized procaine hydrochloride crystals[1] in ampules of stated dosage.
6. Ephedrine, 50 milligrams for hypodermic injection.
7. Procaine solution for skin anæsthesia.

Procedure

The needles and syringes are carefully flushed out with sterile water.

With the patient in the lateral position, a wide field in the lumbar region is prepared with 3½ per cent tincture of iodine and an intradermal weal of 1 per cent procaine is made over the third or fourth interspace. Fifty milligrams of ephedrine are injected subcutaneously or intramuscularly.

The puncture is made through the intradermal weal and about 2 cubic centimeters (see below) of spinal fluid are withdrawn with the 5 cubic centimeters syringe. *No spinal fluid is discarded.*

[1] Novocain (procaine hydrochloride—Metz) was used in this series. The sterile crystals may be obtained in ampules containing 50, 100, or 200 milligrams.

One hundred to 200 milligrams of procaine (never more than 250 milligrams) are dissolved in this fluid, diluted to about 4 cubic centimeters, and re-injected at about the speed of a hypodermic injection.

After a sterile dressing is applied over the site of puncture the patient is turned on his back and placed in 15 to 20 degrees Trendelenburg position with a low pillow under his head for comfort.

RESULTS

Level of anæsthesia. In order to operate satisfactorily upon the stomach or gall bladder the level of skin anæsthesia must be at or above the nipple line. It makes but little difference, so far as reaction of the patient is concerned, whether the level of anæsthesia is at the xyphoid or whether it is at the jugular notch. Koster and Kasman making use of spinal anæsthesia for operations on the head, neck, and upper extremities have shown without question the safety of the procaine spinal fluid method. It seems quite definite from their work that if the injection is given in the lower lumbar region and the dose of procaine is not too great, the concentration of the drug in the upper dorsal and cervical regions is not sufficiently high to cause a paralysis of the motor nerves supplying the diaphragm and intercostal muscles, and therefore the possibility of a paralysis of the accessory muscles of respiration is exceedingly remote. In view of this, it would seem to be of relatively little importance to have accurate control over the level of anæsthesia if the operation is to be upon the abdomen. It is more important to make sure that the level of anæsthesia is sufficiently high to carry out the operation undertaken. In the procaine-spinal fluid method, it is easier to obtain a satisfactory level of anæsthesia than it is to keep the anæsthesia low. The more important factors which seem to influence the level of anæsthesia and over which the operator has control are as follows:

1. The location of the puncture,
2. The force of injection,
3. The amount of fluid withdrawn and re-injected.

Roughly speaking, the higher the space the higher the anæsthesia. Thus, using 200 milli-

TABLE III.—A COMPARISON OF THE DURATION OF ANÆSTHESIA AS ESTIMATED BY THE NUMBER OF CASES IN WHICH SUPPLEMENTARY ANÆSTHESIA WAS USED

Type of anæsthesia	Average dose in mgm. of procaine	Duration of operation								
		One hr. or less			One to 1½ hrs.			More than 1½ hrs.		
		No. Cases	Supplementary anæsthesia No.	per cent	No. Cases	Supplementary anæsthesia No.	per cent	No. Cases	Supplementary anæsthesia No.	per cent
Spinocain, (39 cases)	300	20	1	(5)	13	3	(23)	6	0	
Procaine in 5 per cent glucose solution, (116 cases)	300	62	3	(4.8)	29	4	(13.8)	25	9	(36)
Procaine in spinal fluid, (260 cases)	200	117	6	(5.1)	89	9	(10)	54	20	(37)

grams of procaine dissolved in 4 cubic centimeters of spinal fluid, 70 per cent of the cases in which the puncture was in the third lumbar space reached a level at or above the nipple line, whereas 66.6 per cent of the cases in which the puncture was made in the fourth space reached that level.

The force of injection, of course, varies with the individual. It is probably one of the most important factors in the so called knack of giving spinal anæsthesia, and undoubtedly does more than anything else to account for the difference in level of anæsthesia obtained by different men using the same technique. In general, the injection was made at about the same speed used for an ordinary hypodermic medication.

The amount of spinal fluid used to dissolve the procaine will determine, within certain limits, the level of anæsthesia. Our experience has been quite in keeping with that of Stout. Thus, when 2 cubic centimeters of spinal fluid were used to dissolve 200 milligrams of procaine, 31 per cent of the cases had anæsthesia up to or above the nipple line; with 3 cubic centimeters, 50 per cent; with 4 cubic centimeters, 72 per cent; and with 5 cubic centimeters, 87 per cent reached the same level.

The position of the patient on the table during and immediately following the administration of the anæsthesia has little if any influence on the level of anæsthesia in the procaine-spinal fluid method if the larger dilutions of spinal fluid are used. If, however, a concentrated solution such as 200 milligrams of procaine in 1½ cubic centimeters of spinal fluid is used the specific gravity of the solution will be distinctly higher than that of spinal fluid. Therefore, if the patient is immediately turned on his back and hurriedly placed in high Trendelenburg position the solution will diffuse upward much more rapidly than if he remains in the horizontal position, and the level of anæsthesia will readily run up to a level high enough to permit any abdominal procedure. In the use of a special solution, however, such as spinocain or procaine in glucose solution the position of the patient during and immediately following the giving of the anæsthesia is of greatest importance. Sise collected 14 deaths following spinal anæsthesia in Boston due, in 4 cases, to the use of a light solution and the failure on the part of the administrator to realize the importance of keeping the head of the patient low. Regardless of what method of spinal anæsthesia is used, it will probably be impossible to change the level after 5 minutes.

Duration of anæsthesia. The duration of anæsthesia is variable (Table III) although the surgeon can usually depend upon an hour to an hour and 15 minutes of anæsthesia in the upper part of the abdomen. Two and four tenths (2.4) per cent of our cases required some type of supplementary anæsthesia during the first hour. In contra-distinction to this, 66 per cent of 85 operations which lasted 1½ hours or more were completed without additional anæsthesia. Unknown factors as well as the amount of procaine used determine the duration of the anæsthesia obtained from subarachnoid block. Uncertainty and limitation of the period of anæsthesia are great disadvantages of this form of anæsthesia.

Supplementary anæsthesia. Ten and eight tenths per cent of our patients required some

form of general anæsthesia for the completion of their operations (Table III). If, as occasionally happens, the level of anæsthesia is too low to permit the surgeon to complete operation, some type of general narcosis is usually indicated. Failure to realize the care necessary in the administration of a general anæsthetic to a patient with the operative field almost completely anæsthetized may result seriously. It was the probable cause of a fatality in one of our cases before the present study was started. Ethylene-oxygen, nitrous-oxide-oxygen, or straight ether was used in our cases. The latter was found to be the simplest, the most effective, and safest.

If, as more frequently happens, the effect of the procaine disappears before the operation can be finished, it is much safer to give a general anæsthetic than when the patient is already partially anæsthetized. If the operation itself has been completed the abdomen can always be closed by the injection of 1 per cent procaine locally. If a general anæsthetic must be used, ether is by far the most satisfactory. It is exceedingly important, however, that the ether be started at the first sign of returning sensation. This may be suggested by slight restlessness on the part of the patient, a change in the character of his breathing, or by a slight tightening of the abdominal muscles. If ether is started slowly at this point by a skilled anæsthetist, the transition between the spinal anæsthesia and the general narcosis of ether will be so gradual that it will not be recognized by the surgeon. If, on the other hand, the patient is allowed to go until he is definitely straining, the transition may be a very stormy one and may undo all the good effects of spinal anæsthesia.

We have already suggested that morphine is not a substitute for general anæsthesia under these circumstances and ought never to be used in the hope of avoiding it.

Nausea and vomiting during operation. Nausea and, less frequently, vomiting occurred in about 25 per cent of the patients during the course of anæsthesia. These symptoms usually develop within 15 or 20 minutes after the injection of the procaine and subside after 5 to 10 minutes, although in a few instances they continue throughout the operation. When present they seemed to parallel in point of time the maximum fall of the blood pressure. They may occur in any operation but are more common in operations on the gall bladder and stomach. In a few instances vomiting occurred before the introduction of the anæsthetic and was probably due to the preliminary medication. The method used in the induction of anæsthesia seemed to have no bearing upon the incidence. Not infrequently a series of deep inspirations on the part of the patient would ward off actual vomiting. If this was ineffective a few inhalations of carbon-dioxide (25 per cent) mixed with oxygen (75 per cent) were frequently curative. Fortunately, when it did occur the relaxation of the abdominal muscles was so great that it was not as disturbing to the surgeon as it would have been with a patient under general anæsthesia.

The abdominal relaxation obtained in a patient under spinal anæsthesia is ideal. The abdominal muscles are completely paralyzed; the intestines contract; respirations are very quiet. There is no other anæsthesia which gives such ideal working conditions within the abdomen. The surgeon is undoubtedly able to work with less local trauma, less soiling, and with greater facility than when working with any type of general anæsthesia. All of these advantages, however, will be rapidly lost if the patient is permitted to have a return of sensation before the operation is finished and before some type of supplementary anæsthesia is started.

Blood pressure changes during and following spinal anæsthesia. In this series of cases the pulse, respirations, and systolic and diastolic blood pressure were recorded before the anæsthetic was given and at 10-minute intervals during the course of the operation. In addition to this, postoperative pulse and blood pressure readings were recorded every half hour for 2 hours, and then every 2 hours until the pre-operative level was re-established or, at least, until a constant level was reached. The average duration of the postoperative period of observation was about 18 hours.

Analysis of cases with a fall of 50 per cent or more in blood pressure. A careful analysis was made of the group of 45 (10.8 per cent) of the

415 patients whose fall in systolic blood pressure during the operation was 50 per cent or more of the pre-operative level. The distribution of these 45 cases according to the method of anæsthesia was as follows:

Spinocain, 10 cases, 25 per cent of all spinocain cases
Glucose solvent, 15 cases, 12.9 per cent of all glucose cases
Crystals and spinal fluid, 20 cases, 7.6 per cent of all crystal cases

Age. Thirty-seven, or 82 per cent, of the 45 cases were 50 years of age or older whereas but 47 per cent of the entire series were in this age group. As a corollary to this observation it was noted that patients under twenty years of age rarely show more than a slight fall of blood pressure after spinal anæsthesia.

Sex. Of this group, 31, or 69 per cent, were males whereas of the entire series 200 or 48.5 per cent were males.

Pre-operative medication. No relation could be demonstrated between the degree of fall in blood pressure and the dosage or kind of drug used as preliminary medication.

Dosage of procaine. The fall of blood pressure appeared to bear no relation to the amount of procaine used. There were wide variations in the degree of blood pressure changes in cases all of which had the same dose of anæsthetic.

Level of anæsthesia. In this group of patients with 50 per cent or a greater fall in systolic pressure the level of anæsthesia was at or above the xyphoid process in each case. There was no apparent relation between the height of anæsthesia above this level and the percentage of blood pressure fall.

Pre-operative level of blood pressure. In 10 cases (22 per cent) the pre-operative blood pressure was above 150 systolic. One case (2.2 per cent) had a pressure below 100 systolic. In the 10 cases with a pressure above 150 millimeters, there was no consistent correlation between the level of pre-operative pressure and the percentage fall.

Time after induction of anæsthesia when the maximum fall occurs. The maximum fall in blood pressure usually occurred within the first 30 minutes after injection was made. This was true in 70 per cent of the 45 cases in the series whereas in 37 or 82 per cent of the cases the lowest blood pressure came within the first 40 minutes (Fig. 1). If the blood pressure continues to fall after the first 40 minutes, it is quite probable that there is some other factor at fault.

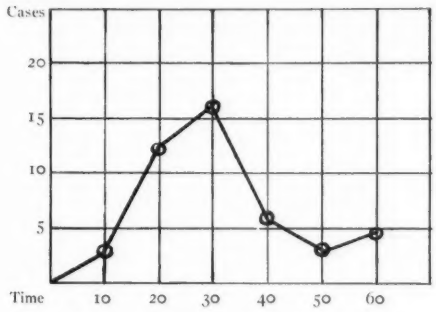

Fig. 1. Time after injection of anæsthetic when maximum fall in blood pressure occurs.

Time necessary for the restoration of blood pressure. The blood pressure was followed for 20 hours after the patients returned to the wards. It is of interest and perhaps of considerable significance that in 25 per cent of these cases the pressure did not return to the pre-operative level during the period of observation; 22 per cent of the patients, on the other hand, did return to their pre-operative level of blood pressure within an hour after their return; and 59 per cent within the first 10 hours.

Complications following marked fall in blood pressure. In Table IV are listed complications which occurred in this group of 45 patients where the fall in blood pressure was 50 per cent of the pre-operative level. Although it might have first appeared that the cause of death of several of these patients was related to spinal anæsthesia, a careful study of their records made this seem unlikely.

Effects of spinal anæsthesia upon patients with hypertension. There is divergence of opinion as to whether or not high blood pressure represents an indication for, or a contra-indication to the use of spinal anæsthesia. In order to study our own results in these cases, those with a pre-operative systolic blood pressure of 150 millimeters of mercury or over were considered to have hypertension. We have arbitrarily selected 150 millimeters in order to include as large a number as possible.

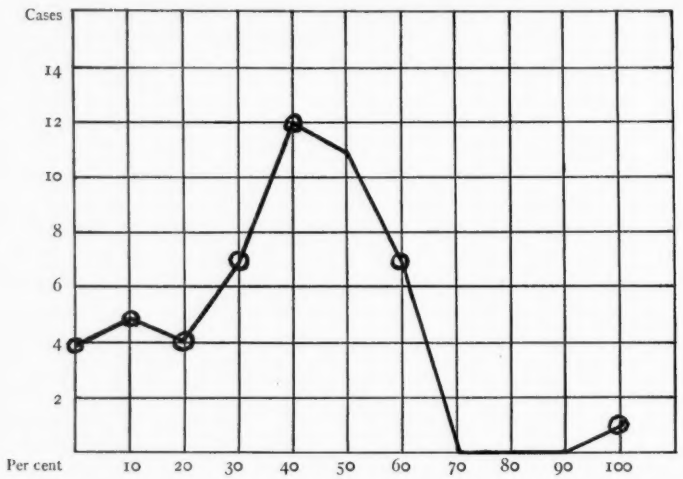

Fig. 2. Percentage of fall in systolic blood pressure in 50 hypertensive cases.

Fifty (12 per cent) of the 415 cases could be placed in this group. The effect of spinal anæsthesia upon the blood pressure of these patients is shown in Figure 2. In 18 per cent of these patients the systolic pressure fell 50 per cent or more, whereas in 64 per cent the fall was 40 per cent or less. In 32 of this group a careful record of their postoperative pressure was kept for a period of 20 hours. It is interesting to note that 47 per cent of these patients had not returned to the pre-operative level of blood pressure during the period of observation.

Only 9 patients in the entire series of 415 had a systolic pressure of 190 millimeters of mercury or more before operation. Of the 9 cases, 44 per cent had a drop in blood pressure which amounted to 50 per cent or more of the pre-operative level (Table V). In one case, that of an old man of 80 years, the only patient in the series who did not receive a preliminary dose of ephedrine, a blood pressure reading could not be obtained after 25 minutes. In spite of this, postoperative convalescence was entirely satisfactory. It is, obviously, impossible to draw any conclusions from so small a series as this. It seems fair to assume, however, that it is in this group that a marked fall in blood pressure might be expected to occur. It is also undoubtedly true that whereas one patient with a systolic pressure of 190 millimeters or more of mercury might tolerate a marked fall in blood pressure with little if any reaction, another patient may find it very difficult to readjust his circulatory balance after it had been affected by such a sudden and profound disturbance. It is possible that the ill effects to the patient with a marked hypertension comes, not so much on the operating table as in first few days of convalescence.

TABLE IV.—POSTOPERATIVE COMPLICATIONS WHEN FALL IN BLOOD PRESSURE WAS 50 PER CENT OR MORE OF THE PRE-OPERATIVE LEVEL

Postoperative complication	Number	Dead
Peritonitis	3	3
Pneumonia	2	2
Shock	3	3
Septicæmia	1	1
Intestinal obstruction	1	1
Cerebral thrombosis	1	1
Bronchitis	1	0
	12	11

Postoperative complications in patients with hypertension. The lack of correlation between the fall in blood pressure and the occurrence of postoperative complications is not so obvious in this group as in the previous one (Compare Tables IV and VI).

Effects of spinal anæsthesia upon patients with hypotension.[1] There were 33 patients with

[1]Not due to shock.

TABLE V.—BLOOD PRESSURE CHANGES IN 9 PATIENTS WITH A SYSTOLIC PRESSURE OF 190 MILLIMETERS OR MORE OF MERCURY BEFORE INDUCTION OF SPINAL ANÆSTHESIA

Case No.	Systolic pressure	Fall in pressure per cent	Time necessary to return to pre-operative level	Result
295705	220	18	Not in 14 hrs.	Recovered
299112	190	11	6 hours	Recovered
295669	210	45	20 hours	Recovered
297846	210	45	10 hours	Recovered
294695	195	25	2 hours	Recovered
297247	200	100	Not in 18 hours	Recovered
300459	190	37	1½ hrs. (fall later)	Died pulmonary œdema
281999	210	59	Not in 20 hrs.	Recovered
297942	190	55	2 hours	Recovered

a pre-operative systolic blood pressure of 100 millimeters of mercury or less. It is interesting to note that in 11 cases (33 per cent) the blood pressure rose instead of falling and that in only 5 cases (15 per cent) was there a fall in pressure of 50 per cent or more. As with those patients whose blood pressure was 150 millimeters or more, the maximum fall occurred in 68 per cent within the first 40 minutes. Quite in contrast with the hypertension group, however, is the time necessary for the blood pressure to return to the pre-operative level. Eighteen patients with hypotension were completely followed in this respect. Of this number all had either regained or exceeded the pre-operative level within 30 minutes after the operation was completed.

The effect of restorative measures on blood pressure after it has fallen. Efforts to restore blood pressure were resorted to infrequently. Table VII shows in detail those cases in which it was used and the method employed. It can be seen from this that our experience with ephedrine or adrenalin given after the fall in pressure occurred has been unsatisfactory. Intravenous injections of 500 to 750 cubic centimeters of 10 per cent glucose, however, were successful in every instance.

The effects of spinal anæsthesia upon the respiratory system. Four cases in which respiratory embarrassment occurred are, it seems to us, of sufficient importance to warrant their report in detail.

CASE NO. 296643, female, 45 years of age, presumably in good physical condition was given a preliminary narcotic consisting of ¼ grain morphine and 1–100 grain scopolamin, 30 minutes before operation. Her blood pressure was 170–90. She had the usual pre-operative ephedrine, 50 milligrams subcutaneously; 300 milligrams of procaine in 5 per cent glucose solution produced anæsthesia to the mid-sternum. The blood pressure fell within 30 minutes to 90–50. Coincident with this the patient became faint and cyanotic; the respirations were shallow and gasping, and the patient went into a comatose condition. High Trendelenburg position and carbon dioxide and oxygen inhalations resulted in complete recovery in 20 minutes. A cholecystectomy was done. Convalescence was uneventful.

CASE NO. 297247, a colored man 80 years of age, entered the emergency ward with a tremendous strangulated inguinal hernia. He was not a good operative risk; his blood pressure was 200–100 and he was considered to have hypertensive heart disease. He was given 1/6 grain morphine ½ hour before operation. No ephedrine was given. Three hundred milligrams of procaine in 5 per cent glucose gave anæsthesia to the costal margin. Within 20 minutes it was impossible to get his blood pressure, respirations became Cheynes-Stokes in character, and he became unconscious. Respirations could always be stimulated by carbon-dioxide and oxygen. He recovered satisfactorily in about 6 hours and his convalescence following that was uneventful. Although at the time it was considered unwise to lower his head because of the heavy solution, it would undoubtedly have been safe and was definitely indicated.

CASE NO. 301345 was a toxic, debilitated man of 50 years with an extensive ulcerative colitis. His pre-operative blood pressure was 90–60. He was given no preliminary medication save the usual 50 milligrams of ephedrine.

TABLE VI.—POSTOPERATIVE COMPLICATIONS OCCURRING IN 50 PATIENTS WHOSE PRE-OPERATIVE BLOOD PRESSURE WAS 150 MILLIMETERS OR MORE OF MERCURY

Postoperative complication	Cases	Dead
Sudden death	2	2
Extensive sepsis	1	1
Peritonitis	1	1
Bronchopneumonia	1	..
Melancholia*	1	..
Irrational†	1	..
Laryngitis	1	..
Persistent vomiting (one week)	1	..
Severe distension	2	..

*Involutional melancholia (menopausal). Discharged to Psychopathic Hospital. Patient had an exacerbation after operation.

†Patient acquired from neurological service where he had been studied for similar episodes before.

TABLE VII.—EFFECT OF RESTORATIVE MEASURES ON PATIENTS WITH PROFOUND FALL IN BLOOD PRESSURE FROM SPINAL ANÆSTHESIA

Restorative measure	Cases
Intravenous infusion of 10 per cent glucose, 8 cases	
Rapid rise in all	8
Ephedrine 2d dose, 15 cases	
No change	10
Gradual rise (over 30 to 40 min.)	3
Fall in blood pressure	1
Obscured by intravenous	1
Adrenalin, 8 cases	
No change	3
Gradual rise	3
Return to normal (30 min.)	1
Fall	1

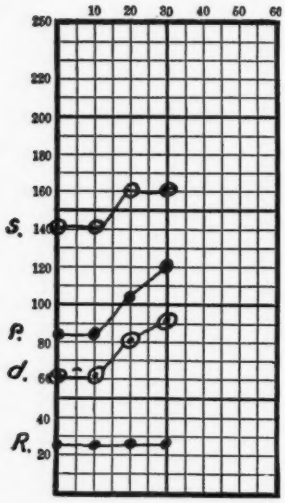

Fig. 3. Blood pressure (S. D.), pulse (P.), and respirations (R.) to within few minutes of cessation of respirations in Case No. 300374.

Following the injection of 200 milligrams of procaine dissolved in 4 cubic centimeters of spinal fluid his blood pressure fell rapidly to 30–0, he became cyanotic, perspired profusely, and his respirations became shallow and irregular. He responded satisfactorily to Trendelenburg position, carbon dioxide and oxygen, and intravenous glucose solution. He subsequently did well following ileostomy.

Case No. 300374, an apparently healthy young woman of 42 years was to have a pelvic repair. Her pre-operative blood pressure was 140–60. Careful physical examination failed to reveal any definite physical handicap save for the fact that she was obese. There was no particular indication or contra-indication to any type of anæsthesia. Her pre-operative medication consisted of ⅛ grain morphine, 1/200 grain scopolamin, 1½ hours and ⅙ grain morphine and 1/200 grain scopolamin, ½ hour before operation. Fifty milligrams of ephedrine sulphate were given subcutaneously just before the lumbar puncture was done. Three hundred and fifty milligrams of procaine crystals were dissolved in 3 cubic centimeters of spinal fluid and injected at the level of the third lumbar interspace. The patient was then placed in Trendelenburg position. She was attended by a nurse anæsthetist who had just begun to learn to administer anæsthetics. Thirty minutes after the injection, her blood pressure was 160–90 millimeters of mercury, her pulse 120, and her respirations 24 (Fig. 3). A few minutes later the surgeon, while doing an anterior colporrhaphy, noted that the patient's blood was dark. Within 5 minutes of this time respirations ceased. The pulse was fair; its rate not recorded. Artificial respirations were at once instituted with a bag containing carbon dioxide and oxygen over the face. Before the injection of intravenous glucose could be started, the temporal pulse had disappeared and it became impossible to feel any apex impulse. After about 200 cubic centimeters of 10 per cent glucose with 10 minims of adrenalin chloride had been injected intravenously the pulse returned, the patient's color improved, and the apex impulse became sufficiently marked so that the person doing artificial respiration could readily feel it. After about 30 minutes of artificial respirations, there were a few voluntary inspirations on the part of the patient but the pulse which had for a period of 15 minutes remained strikingly good gradually became weaker, and after the first few inspirations disappeared. All further attempts at resuscitation failed, although they were kept up for approximately an hour. Autopsy showed no obvious cause of death. Fluid withdrawn from the cistern, however, showed a recognizable trace of novocain 1½ hours after induction of anæsthesia.

In the first three cases above, we believe that the respiratory complication was due to cerebral anæmia. We believe this because of the improvement which occurred when the patient was placed in Trendelenburg position and because of the consistent response to carbon dioxide and oxygen regardless of the position the patient was in. We have seen these manifestations in cases not included in this series and the response to position and carbon dioxide and oxygen has been uniformly good.

Case No. 300374, however, represents what we believe to be a death due strictly to spinal anæsthesia. Death in this instance is most satisfactorily explained by a paralysis of the accessory muscles of respiration. There is no end of evidence to show that the sensory nerves are much more susceptible to procaine than are the motor nerves and that procaine in insufficient concentration to cause a paralysis of motor nerves will give anæsthesia. How wide this margin is we do not know. It is not unusual in high spinal anæsthesia to see the respirations of the patient become very shallow due, apparently, to failure of all or a part of the intercostal muscles to function. Should it so happen that the procaine reaches the cervical region in sufficient concentration to cause a paralysis not only of the intercostal nerves but also of both phrenic nerves, paralysis of respiration would result not from any effect upon the respiratory center, but from mere inability on the part of the patient to breathe. In this case the sustained, in fact elevated, blood pressure until just before the patient stopped breathing and, in addition to this, the continuation of heart action beyond the time when respirations ceased are, we believe, evidence of confirmation of this interpretation. Under such conditions carbon dioxide and oxygen would be of no value until

TABLE VIII.—ALL COMPLICATIONS IN ORDER OF FREQUENCY OCCURRING IN 338 PATIENTS AFTER OPERATION UNDER SPINAL ANÆSTHESIA

Complications of respiratory system:	
Pneumonia, alone or with another complication	18
Bronchitis	10
Massive collapse of the lung	2
Pulmonary embolus	2
Pleurisy with effusion	1
Laryngitis and tracheitus	1
	34
Wound sepsis (minor 8, major 8)	16
Peritonitis (alone or with another complication)	12
Headache (slight; up to 48 hours)	6
Shock	3
Separation of wound (requiring suture)	3
Phlebitis	2
Cystitis and pyelitis	2
Decubitus ulcer	1
Intestinal obstruction	1
Cardiac decompensation	1
Cerebral thrombosis	1
Gastric fistula	1
Staphylococcus septicæmia	1
Total	84

there was a return of function of the diaphragm. To be successful, resuscitative measures should be instituted coincident with or just before the complete cessation of respiration. It is quite possible that in this instance earlier institution of proper resuscitative measures might have prevented a fatal outcome.

RELATION OF SPINAL ANÆSTHESIA TO POSTOPERATIVE COMPLICATIONS

Complications due to spinal puncture. A careful study of the postoperative course and outcome in 338 of the 415 cases was made (Table VIII). Complications due to the spinal puncture itself were rare. There were no cases of meningitis or meningismus. Pain in the back or over the site of puncture occurred in a few cases but was never of any great consequence. Headache, often spoken of in the writings on this subject, occurred in only 6 cases and with but one exception it was very transient. In this instance it lasted for 48 hours.

Complications of the respiratory system. It was a great disappointment to find complications of the respiratory system accounting for 40 per cent of those occurring in this series. It was hoped in this study to be able to confirm the opinion of others that spinal anæsthesia has a marked influence on lowering the incidence of postoperative pulmonary infections. While it is true that in some instances this form of anæsthesia was selected because of the presence of some pre-existing respiratory infection, and although the postoperative complications are probably more carefully recorded in this series of cases than in the hospital records, these facts alone would not account for the unfavorable comparison which the East Surgical Service (spinal) makes with the corresponding West Service (Table IX). It is also true that a large number of these patients were very poor operative risks; some were old, others debilitated by chronic disease, and a large number had advanced malignancy. It was nevertheless in these groups that it was hoped to lessen the incidence of pulmonary complications.

TABLE IX.—COMPARISON OF COMPLICATIONS OF THE RESPIRATORY SYSTEM OCCURRING ON THE EAST AND WEST SURGICAL SERVICES OF THE MASSACHUSETTS GENERAL HOSPITAL

	East Surgical Service (spinal year)		*West Surgical Service* (ether used mostly)	
	1927-1928	*1928-1929*	*1927-1928*	*1928-1929*
Pneumonia	22	29	28	22
Massive collapse	15	5	7	4
Pulmonary emboius	0	5	7	4
Bronchitis	0	11	0	3
Pleurisy	1	2	1	1
Upper respiratory infection	1	1	3	3
Total	39	53	46	37

Of the 6 deaths from pneumonia, one occurred in a patient who had a pneumococcus upper respiratory infection with beginning pneumonia before he was operated upon for a perforated duodenal ulcer. A second was in a patient who had a sore throat.

Since the completion of the year required for this study a more careful consideration of the pulmonary conditions following operation suggests that many of the cases herein called "bronchitis" may best have been classified as atelectasis. The recent work (unpublished) of our colleague Dr. Donald S. King even suggests that the incidence of pulmonary atelectasis in patients who have had spinal anæsthesia may be much higher than in those patients

TABLE X.—CAUSE OF DEATH IN 40 OF 338 PATIENTS OPERATED UPON UNDER SPINAL ANÆSTHESIA

A. Deaths from primary disease:	
Acute cardiac failure (mistake in diagnosis)	1
Gastric hæmorrhage from ulcer	1
Cirrhosis of the liver	1
Advanced peritonitis	3
Cerebral metastases from gastric carcinoma	1
	7
B. Deaths from complications:	
Pneumonia	6
Peritonitis	8
Peritonitis plus pneumonia (definite pneumonia)	5
Phthisis plus septic wound	1
Intestinal obstruction	1
Cerebral thrombosis (?)	1
Pulmonary embolus	1
Gastric fistula	1
Staphylococcus septicæmia	1
Cause unknown (? embolus)	1
	26
C. Sudden Death—cause uncertain	6
D. Death from anæsthesia:	
Respiratory failure	1

operated upon under inhalation anæsthesia. In the light of these results one would not be justified in choosing spinal anæsthesia with the expectation of preventing a pulmonary complication.

Deaths occurring in this series from all causes. Of the 338 patients whose outcome was carefully recorded there were 40 deaths, a mortality of 11.8 per cent. A classification of these according to cause is given in the accompanying table (Table X).

It is at once apparent that the majority of fatalities in the series could have had no connection with the type of anæsthesia. There were few deaths, however, which might bear some relation to the anæsthesia and therefore deserve brief mention.

There were 6 patients who died suddenly within 48 hours of operation, 4 of whom died almost exactly the same way. All of these patients were over 50 years of age. Only one had a systolic blood pressure of above 120 millimeters of mercury. Hers was 190—100. The manner of death is well illustrated by the latter patient who, having had a complete hysterectomy for carcinoma of the fundus, had been quite well until the evening of the second day. At this time, she began to have pain in the chest, her lungs filled up rapidly with fluid, manifested by loud, moist râles everywhere over the chest, and she died within 12 hours apparently of acute pulmonary œdema. Three other patients died under very similar circumstances. Unfortunately, autopsy permission could not be obtained in any of these cases. It was thought that they died of circulatory collapse but the relation, if any, to the type of anæsthesia used is not clear. A fifth case died of shock and a sixth, in the last stage of cirrhosis of the liver, died of his primary disease. In no case was the fall in blood pressure during anæsthesia very remarkable. Two had a fall of somewhat more than 50 per cent. It is only fair to say that one of these patients had a 4 day, acute intestinal obstruction and was in rather a precarious condition, and that another had an advanced carcinoma of the stomach with extensive metastases. A third was an aged man who had a gastrostomy for cancer of the œsophagus. The end-result in these 3 last patients therefore was not unexpected. Death, nevertheless, did come in a sudden and unexpected manner.

Postoperative pneumonia is usually regarded as a relatively benign disease, but of the 13 patients who developed this complication in this series 6 died—a mortality of 46 per cent. Two of the fatal cases were given ether and a third nitrous oxide and oxygen to supplement the spinal anæsthesia.

CONCLUSIONS

1. Spinal anæsthesia does not fulfill all of the requirements essential to the ideal anæsthetic for abdominal surgery. Nevertheless, it has an important place in surgery below the diaphragm.

2. The indications for and the contra-indications to its use are difficult to enumerate. It is safe in experienced hands. It is indicated in operations of an hour to an hour and fifteen minutes duration, in the presence of diabetes, tuberculosis, or where there is definite damage to kidneys or liver. It is indicated in long operations whenever it is desirable to spare the patient an hour or more of general anæsthesia. It is contra-indicated in perforations of the intestines because, through its effect on peristalsis, intestinal contents may be emptied into the abdominal cavity. It is also

contra-indicated in a patient on the verge of collapse, in a patient where the nature of the condition contra-indicates the Trendelenburg position (general peritonitis), in any patient where a sudden fall in blood pressure might be hazardous, and for any operative procedure upon a very sick patient which can be successfully carried out under local anæsthesia.

3. There is no evidence that hypertension *per se* is a contra-indication to spinal anæsthesia. It is nevertheless true that in patients with a systolic blood pressure of 190 millimeters or more of mercury, a fall of 50 per cent or more of this level frequently occurs and may result in temporary respiratory embarrassment. It is quite probable that spinal anæsthesia does little, if anything, to reduce the risk of abdominal operations in the group of patients with hypertension and arteriosclerosis and at times may increase it through a disturbance of their cardiovascular balance.

4. Spinocain, procaine hydrochloride in 5 per cent glucose solution, and procaine hydrochloride crystals dissolved in the patient's spinal fluid were the methods used. Reinjection of a solution of procaine crystals in the spinal fluid is believed to be the safest, easiest, and most dependable method.

5. The advantages of spinal anæsthesia are complete relaxation, quiet respirations, contracted intestines, a probable lack of direct irritation to kidneys, liver, and lungs, and the absence of any direct effect upon the metabolism of a patient with diabetes mellitus.

6. The disadvantages of spinal anæsthesia are the short, uncertain period of anæsthesia, the uncertainty of its effect upon blood pressure, occasional nausea and vomiting occurring during operation, and the slight handicap of working in the upper abdomen with the patient in Trendelenburg position.

7. The effect of spinal anæsthesia on postoperative complications in a series of 338 unselected cases is a disappointment. During the year in which spinal anæsthesia was used on the East Surgical Service at the Massachusetts General Hospital, there was an apparent increase in the number of postoperative pulmonary complications over that of the preceding year and over that on the West Surgical Service which used the routine inhalation anæsthesia. While spinal anæsthesia is not irritating to the lungs and may lessen the incidence of postoperative complications when operation is necessary in young patients who already have an acute respiratory infection, there is no evidence at hand to show that spinal anæsthesia materially lessens the postoperative complications of the respiratory system in elderly and debilitated patients. An increase in the incidence of atelectasis which in turn may lead to more serious conditions is suggested as a possible explanation for this.

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EDITORIALS

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APRIL, 1931

HOMEOSTASIS OF THE FLUID MATRIX AS AFFECTED BY EXTEROFECTIVE AND INTEROFECTIVE NERVE SYSTEMS

OUR bodies are composed of highly unstable material, so unstable indeed that only a few minutes of oxygen-lack results in such profound decomposition of important parts that they cannot recover from it. In spite of this high degree of instability of the substance of our organization, the organization itself exhibits and preserves a marvelous stability. For example, what machine has ever been constructed which will maintain for three score years and more a temperature so uniform as that of human beings? It allows thermometer makers to put a "normal temperature" mark on their instruments which is serviceable in the Arctic circle and under tropical suns, and with peoples of all varieties of race and labor.

We commonly think of ourselves as air-inhabiting animals, but in fact we are separated from the air about us by dead stuff—by a layer of horny scales or by salty water and mucus. All that is living in our organization lies within these dead surfaces and is bathed in the fluids of the body, the blood and lymph, which may be called the "internal environment" or *fluid matrix*. Claude Bernard, the great French physiologist, showed keen insight when he pointed out that the constancy of the organism depended on the constancy of its internal environment. He clearly recognized that as organisms have evolved from less complex to more complex forms they have obtained gradually more and more control over the internal environment until its constancy in mammalian forms is highly perfected. The frog, unable to control its body temperature, must hibernate in the mud during the winter. The mammal, with the same temperature surroundings for its living parts whether the outer atmosphere is cold or hot, is liberated from the vicissitudes of the external environment. As Bernard expressed it, "The fixity of the internal environment is the condition of free and independent life."

The fairly steady states of the internal environment—its fairly constant temperature, its only slightly variable hydrogen-ion concentration, its regulated sugar content, its fixed osmotic pressure—might be called "equilibria," but that term has a definite significance in physicochemical states having a relatively simple character. The steady states in our bodies are maintained by highly indirect and complicated physiological reactions. So it seems desirable to designate the idea of constancy in living organisms by a special term; I have suggested the name, "homeostasis." It does not mean constancy in the sense of stagnation, but constancy, or relative constancy, in the sense of condition.

Not only are changes in the outer world capable of disturbing the body fluids and consequently the internal environment, but the activities of the organism itself are continually bringing about alterations. When we run, we utilize blood sugar, we produce acid, we develop heat. All these changes, if continued to extremes, would result necessarily in lessened capacity to run. Before that stage of inefficiency has even threatened, reactions occur to protect the body against it. For example, a shift of the blood in the direction of an acid reaction, as a consequence of muscular exertion, is promptly met by a rise of blood pressure, a faster heart rate, a deeper breathing, all of which reactions are directed toward carriage of oxygen more rapidly and more abundantly to the parts where non-volatile lactic acid is being developed, so that it may be burned to volatile carbonic acid, and toward carriage of that volatile acid more rapidly and in larger volumes to the lungs to be disposed of.

A survey of the complex of reactions hinted at in the foregoing paragraphs leads to the functional separation of the nervous system into two main divisions. One of these is in control of skeletal muscle. By means of it we bring about all the marvelous changes in the outer world, from X-radiations to airplanes and sky-scrapers, that characterize our present civilization, or we alter our relations to that world. That is the *outward*-working portion, the "exterofective" division of the nervous system. As pointed out above, whenever we become active through use of the exterofective division, we change the *internal* environment. And unless this change is met by corrective measures, the fitness of the internal environment for continued action becomes impaired. It is at this stage that the other division of the nervous system comes into play—the *inward*-working portion or the "interofective" division. The main part of this division, the part chiefly concerned with maintaining homeostasis, is the sympathetic system. It liberates sugar from the liver when the sugar level tends to fall. It discharges heat-producing adrenin, contracts the blood vessels and erects the hairs in cold weather. It causes secretion of sweat when the body temperature begins to rise. It produces the alterations in the heart rate and in the blood vessels, mentioned above, that are necessary for a faster circulation when non-volatile acid must be quickly burned to preserve the normal reaction of the blood.

The sympathetic system, therefore, is the main interofective agency controlling homeostasis. To it we owe our ability to continue our lives under uniform conditions, in spite of great variations of circumstances in the outer world and in spite of large chances of disaster from changes in the fluid matrix of the body. As recent experiments have shown, animals can be kept alive indefinitely with the sympathetic system eliminated from any possibility of functional use to the organism. But such animals must live in a practically uniform temperature, and must be freed from the necessity of struggle for food or safety. In losing the services of the sympathetic part of the interofective division of the nervous system, they have lost control of that "fixity of the internal environment" which "is the condition of free and independent life."

WALTER B. CANNON.

SURGICAL PRINCIPLES

IT would be well for the surgeon and patient alike if the former had constantly in mind the fact that the human body is composed of delicate living cells. It matters little to the patient or to the relatives that a satisfactory operative procedure was completed, if the former succumbs as a result of the operation. It

is important, therefore, to evaluate properly the different features of the patient's condition and to treat him as an individual rather than as a case—in other words the operation should be planned and executed so as best to meet the needs of the individual patient.

In emergency cases it is often necessary to operate immediately regardless of minor contra-indications, in order to save life. But there are not many conditions in which surgery is so urgently indicated that time may not be taken to give the patient a blood transfusion or to administer glucose intravenously or saline subcutaneously. Sometimes, as in acute abdominal catastrophies, it may be impossible to establish a correct pre-operative diagnosis—nor should valuable time be lost in such cases in an attempt to make an absolute diagnosis before operation. Here the surgeon must be satisfied with the decision that a surgical condition exists and that immediate operation is imperative. But in the average so called chronic case, a conscientious effort should be made to establish a correct diagnosis before operation. In this connection it is gratifying to observe that the term "exploratory laparotomy" is now seldom used.

The surgeon should make his own diagnosis or at least be sufficiently acquainted with the patient's condition to enable him conscientiously to agree or disagree with the diagnosis already made.

A factor contributing greatly to better operative results is the tendency of physicians and surgeons to emphasize more and more the importance of the pre-operative treatment of the patient. It is no longer considered good treatment to perform a major operation for a chronic ailment upon a patient admitted to the hospital the evening or night before without preliminary preparation and observation. It is illogical to expect a patient, who is toxic and dehydrated, to withstand an extensive surgical procedure without suffering severely from shock. Adequate and carefully supervised pre-operative hospitalization for several days or more, if necessary, will always improve the patient's condition for surgery. Such pre-operative treatment followed by a well planned, carefully and dexterously executed operation will do much to simplify postoperative treatment and to insure a smooth convalescence.

Good surgery demands proper exposure, gentleness in handling tissues, careful hæmostasis, and such speed as is consistent with satisfactory work. The surgeon should not sacrifice hæmostasis and gentleness for speed but should gradually develop the kind of speed which results from dexterous, purposeful movements each of which counts. Excessive traction upon the abdominal viscera is one of the chief causes of shock. Rough handling and bruising of the tissues contributes largely to the postoperative abdominal complications so frequently seen. The central nervous system registers the shock resulting from such trauma. The incision must be long enough to permit thorough exposure of the operative field without employing undue traction. This is one of the cardinal principles in surgery. Would it not be a great contribution to good surgery if, in the early years of his professional career, every surgeon experienced at least one operation under local anæsthesia?

Provision should be made for the maintenance of proper body heat during operation. This is especially important during operations about the liver.

Surgery of the female reproductive organs, for the removal of benign lesions, should be conservative.

An unreasonable amount of surgery should not be performed at one time even though the patient be a good surgical risk. Graded operative procedures are frequently life-saving

measures. Especially is this true of operations performed upon the colon in the presence of obstruction, whether due to malignancy or to other causes. Obstruction should always be relieved early.

It is unreasonable to expect the lower colon, especially if inflamed and indurated as it frequently is, to absorb sufficient liquids to maintain the proper fluid level of the tissues during the first few postoperative days. A much more accurate and reliable method is to supply the tissues with the proper quantity of fluids by subcutaneous or intravenous administration.

The different surgical procedures have been fairly well worked out and standardized. Refinements in technique are constantly being added. The range of operability is gradually being extended in many serious conditions. Old methods are giving way to new. But it is logical to assume that surgery of the future will progress largely in conjunction with, and as a result of, researches which will be made in physiology, bio-chemistry, and biophysics.

C. C. HOKE.

THE AMERICAN JOURNAL OF CANCER

THE appearance of the *American Journal of Cancer* in January, 1931, marks the beginning of an important addition to periodic medical literature. This new journal, which is the official organ of the American Association for Cancer Research and of the American Society for the Control of Cancer, is a continuation of *The Journal for Cancer Research* and has a greatly enlarged editorial board with a correspondingly broader scope for the journal. The first number contains 561 pages of which 243 are devoted to abstracts of the cancer literature, and both the original articles and the abstracts deal with all phases of the technical, administrative, and education problems that are offered by the malignant diseases. The contemporary history of cancer, wherever it may be produced, will be found now in readily accessible and attractive form. The editor, Dr. Francis Carter Wood, is to be congratulated on this first number from the standpoint of its content, its make-up, and its promise.

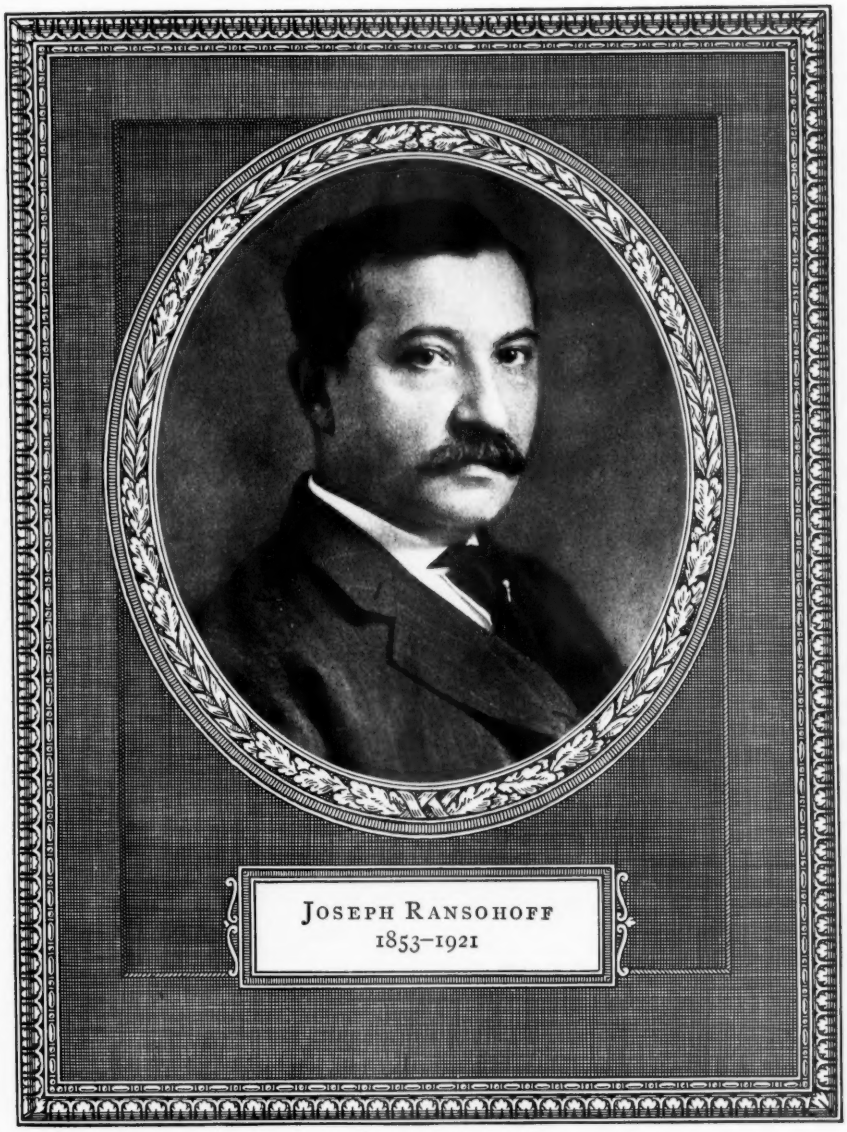
MASTER SURGEONS OF AMERICA

JOSEPH RANSOHOFF

JOSEPH RANSOHOFF was born on the twenty-sixth of May, 1853, in Cincinnati, Ohio, where he graduated, in 1870, from the public high school. He immediately matriculated in medicine, graduating in 1874 from the Medical College of Ohio, which, at this time, was one of the largest and best known schools in the country, numbering on its faculty many inspired and inspiring teachers. After securing his degree, he departed for Europe to devote himself to graduate study in Wurtzburg, Berlin, Vienna, Paris, and London. In these various centers, he came under the stimulating influence not only of the leaders in surgery but also of the pathologists, internists, and the more prominent teachers in allied clinical subjects. Koelliker, Virchow, Langenbeck, Billroth, Tillaux, Paget, Hebra, Rokitansky, Gerhardt, and Hutchinson seem to have made the deepest impress on his medical consciousness.

The European stay was prolonged for 3 years in order that the young enthusiast might attain membership in the Royal College of Surgeons of England. This degree he secured in April, 1877. He was contemplating his return home, when Sir James Paget recognizing his intellectual capacity and enthusiasm encouraged him to present himself at the examination for fellowship in the Royal College. Young Ransohoff accepted the counsel with the result that in June 1877, he won this very distinguished honor within the almost unprecedentedly short interval of 3 months after attaining his membership degree.

During the summer of 1877, Ransohoff returned to Cincinnati where he was almost immediately afforded the opportunities of demonstrating anatomy in the Medical College of Ohio, and of teaching surgery in the college dispensary. In 1879, after the death of the brilliant Langdon Longworth, he advanced to the position of professor of descriptive anatomy. About the same time he was appointed to the staff of the Good Samaritan Hospital, where he began to hold surgical clinics and to display, as a didactic clinical teacher, that unusual genius which won him a life-long following of eager students. It was during these years that he became interested in surgery of the gall bladder, being among that group of American surgeons who were the first to execute operative attacks on this organ. In 1902, he accepted the chair of surgery in the Medical College of Ohio; later in 1909, he was given the same chair in the University of Cincinnati, when



JOSEPH RANSOHOFF
1853–1921

this institution was organized on the basis of a complete university. After the University of Cincinnati was given the control of the Cincinnati General Hospital, he found himself in a position calling for the talents of administrator, teacher, clinician, and stimulator of men. As we count years, Dr. Ransohoff was still a young man, almost a youth, when he found himself confronted with these large tasks.

How well he met the call can be told best in the words of his friend and biographer, Dr. Albert H. Freiberg: "It was now possible for Dr. Ransohoff to do things for the students of medicine not dreamed of when he began his career as teacher. The opportunity he now had for devoting a greater amount of time to teaching was seized with eagerness, which could not have been greater had it been the first chance of his life to show his ability and to establish his reputation. It were entirely fruitless to attempt the analysis of his success as teacher. A sufficient explanation is found in his enthusiasm and in that of his students."

A biography of Dr. Ransohoff in order to be complete must stress not only his disciplined but also his intuitive grasp of surgical diagnosis, the sane conservatism which characterized his method of establishing the indications for surgical intervention, the soundness of his surgical judgment, and the deliberate sureness of his technique as contrasted with the ordinary concept of deadly brilliance.

Over a long stretch of years, he manifested a deep interest in the problems of so called organized medicine, and took seriously to heart the obligations of membership in the several organizations with which he was affiliated. Among these various societies he counted membership in the American Surgical Association, the Southern Surgical Association, and the Western Surgical Association.

His last presentation of a paper occurred in November, 1920, when in spite of the warnings of a rebellious heart, he delivered an address of particular charm on "Drake and Holmes," at the commemoration of the centennial of the Medical School. Following this address, his Alma Mater crowned his 40 years of tireless service with the degree of Doctor of Laws.

At the time of his death, he was director of the surgical service of the Jewish Hospital of Cincinnati and was largely responsible for the outstanding position which this hospital occupies among the institutions of its type.

From the time that he accepted his first teaching position up to within a short period before his death, he worked day in and day out, uninterruptedly, save for the usual vacation outings. During these years, Dr. Ransohoff published a series of one hundred and fifty papers, covering the entire field of general surgery. As an evidence of the evenness of method underlying his surgical life, it is interesting to note that these publications, beginning in 1879 continued up to within 4 months of his death, and that during all these 42 years there were only three that were barren. In addition to these numerous contributions to journal

literature, he contributed to Bryant and Buck's and also to Keen's *Systems of Surgery*.

In August 1920, he suffered a threatening attack of angina pectoris. In spite of a compromised heart, he was able to enjoy 3 months of comparative comfort during the 7 months that intervened between his first and the final attack of angina which caused his death on the 10th of March, 1921.

This finishes the annals of the life of Joseph Ransohoff. But how much the tale smacks of the usual date, place, and name technique of the formal method of historical chronology! The present generation, fortunately, has been schooled, in almost all lands, to look for and to expect more than this. Strachey and Guedella in England, Maurois in France, Ludwig in Germany, Brandes in Denmark, Cushing, Sandburg, Woodward and others in America have fired us with the taste of blood, and we claim as our right to know the man behind names, places, and dates. When we seek for the Joseph Ransohoff in the flesh, we find a lover of home and family, a man of charm and grace, a devotee to the silence of the forest and the warmth of the camp fire, a writer of tales, a teller of stories, *bon vivant*, trusted friend of colleagues and students, worshiper of the great among his colleagues of the past, and a delineator competent to cement his heroes skilfully into the pages of medical history with well turned phrases of a pleasing style. This is the Joseph Ransohoff whose passing is still a poignant memory to his friends at home and at large.

M. G. SEELIG.

¶Incipit Cyrurgia edita ⁊ cõpilata a dño fratre Theodorico epo Cerviesñ ordinis ꝓdicatoꝝ. Cap. ꝓmiale.

Venerabili ⁊ amico charissimo egregio viro dño Aloi gfa epo Valetiñ. frat Theodoric eiusdé patietia Botonitiñ. ecclesie miter idign⁹: opus diuti⁹ affectatuꝝ. ¶Dudũ pr charissime: Rome parit existẽtes: me vrm cũ tpis capellanũ ⁊ penitẽtiarꝝ dñi pape affectuose rogastiꝭ: vt vobis q̃dã artis medicine cyrurgie. s. occulta ⁊ ipsãtia: ⁊ ab antiqs impfecte dicta libꝝ sup hoc facio ꝑ fin meditationẽ dñi Hugonis de Luca viri i ꝓdicta scientia peritissimi apte describer: ⁊ breuiꝫ explicaré. Ego vo volẽs in pte ⁊ ſi nõ in toto satisfacere volis vris: libũ tũc edidi: quẽ eo tpe fuit nostis impfectũ ⁊ incorrectũ more ipatiẽs vobiscũ in Hyspaniã. deportastis. Rogates ⁊ postmodũ p nũcios crebrius iñs expetẽtes: vt vobis eũdẽ libꝝ suppletis defectib⁹ trãsmitter: emẽdatũ. Diu distuli. Sz ecce iã app: opinãte senio: cbristi auxilio iuocato ipso duce artis cyrurgie secreta ꝓposito ois liuoris aculeo aptissime manifesto. ¶Suscipe igitur pr charissime opus eiusdũ imo op⁹ eiusdũ breue coꝛpe: vbiꝫ amplũ.

¶Quia vo modico valde tpe fuit cũ dño Hugõe ꝓdicto necꝫ videre: necꝫ cõprehẽdere: necꝫ discere ad plenũ potuit ex tissimas curas suas. Ideoꝫ in pte ista impfectũ meũ ex ppria expientia ⁊ antiquoꝝ curabo ꝓfice. Baliẽni matie: quẽ a ꝓdicto viro erimio in nullo nouimus discordare. ¶Ut autẽ ad libꝝ istũ accessus facilior hẽat: qd sit cyrurgia. vñ dicat: ẽles opatores hre debeat: necnõ q̃ sit ipoꝝ itẽtio: ⁊ i q̃t videat spes breuiter denotabo.

Cyrurgia igit est opatio manualis i coꝛpe aliis ad sanitatẽ tendẽs. Uel sic. Cyrurgia est vltimũ instrm medicine. Tria enim sunt instra medicine: quibus mediãtibus morboꝝ causa valet medicus subuenire. s. dieta. potio. ⁊ cyrurgia. q̃ Dieta est primum instrm: ⁊ est melius sicut testat Ho. in cõmẽto regiminis acutoꝝ dicẽs. Si possumus boiem curare cũ diete: nõ curemus eum cum aliq̃ potiõe. Et Damas. in affor. Si poteris boiem curare p dietã ꝓsperã inuenies: hoc aũt instrm siue regimẽ exigit ꝯ cãm: ⁊ facit digonẽ. Cra regimen seu instrm est potio: de q̃ idẽ. Ho. Si cũ potiõe infirmitatẽ possum⁹ remouẽ: ad cyrurgiã recurrẽdus nõ est. Si aũt p duo ꝓdicta regimia seu instra remoueri nõ poterit: remoueat bisficio tertij regimis: vz cyrurgie.

¶Dicit autẽ cyrurgia a cyros qõ est manus: ⁊ agia qõ est actio: inde cyrurgia quasi manualis operatio.

¶Oportet opatores cyrurgie: vt dicit Bali. in cõmento frequẽtare loca: vbi pertil cyrurgici operãt ⁊ eoꝝ opationes diligẽter attẽdere ⁊ memorie cõmẽdare. Opꝫ etiaꝫ vt nõ sint temerarii nec audaces: sed sint ꝓuidi: suaues ⁊ cauti: vt cũ maxima deliberatiõe ⁊ suauitate oimoda: qua potuerint operãt: ⁊ maxime circa cerebrũ pãniculoꝝ mẽbra neruosa ⁊ loca alia timorosa. Et qꝫ in libris cõprehẽdi nõ pñt oia que necessaria sunt ad artem: ⁊ frequẽter multa opatõi occurrũt que nõ potuerũt de facili ꝓuideri. Opꝫ medici ingeniosum esse. Damas. enim multum cõmẽdat in medico ingeniũ nãle. Dicit enim. Ingenium medici nãle adiuuat artẽ ⁊ nam regemẽ. ꝓfio vo ꝓsium.

¶Opꝫ etiã eẽ fatoꝝ alo ⁊ si interdũ exprimẽtis iuuent frequẽter tñ in erroꝝ incident ⁊ laberintibũ. vnde enim aliquez sine fio puto posse cõprehẽdere cyrurgiã. Referi enim Almansor: q opatores vultꝫ artis pro maiori pte idiote rudes ⁊ stolidi sunt: ⁊ causa stoliditatis eoꝝ egritudines in bobus pessime gñant. Plerũq; etiaꝫ cũ non apparẽ sub certa radice: necꝫ rõnabiliꝫ ꝓpter ipsoꝝ imperitiam boues occidunt. Causas etiam ⁊ noia infirmitatũ quas asserunt: se sanare penitus non agnoscunt.

¶Intẽtio opationis cyrurgicoꝝ est circa tria. s. circa cõiunctionem solutoꝝ. circa separationem coniunctorum ꝓter naturam ⁊ circa extirpationem superflui.

¶Spẽs cyrurgie sic̃ tetrat Joãnitiꝰ due sũt. Dic. n. cyrurgia est dupꝫ: aut i carne: aut i osse: ⁊ fm ꝓportẽtatẽ mẽbroꝝ ibidẽ: nã alia fit i mẽbris mollib⁹. vt i carne. neruis. uenis. ⁊ silib⁹. Alia fit i mẽbris duris: vt i ossib⁹ ⁊ silib⁹: q̃ sic̃ diuidit tripliciter aut fit i carne tm: q̃ scarificatio vel incisio seu sutura aut icisio nũcupat. Aut fit i venis nõ pulsatilib⁹ aut i pulsatilib⁹: ⁊ dr flomia siue sectio: aut fit i neruis ꝛz latis ⁊ tũc icisio nosat: aut ꝛz lõgũ: ⁊ tũc pũctura dr vt scissura. In dyafragmate ibi ⁊ pãnicul⁹ nosat ruptura. Cyrurgia vo q̃ fit i mẽbris duris dupler ẽ: aut. n. fit i ossib⁹ duris: ⁊ dr restauratio siue ꝓsolidatio fractoꝝ: aut fit i ossib⁹ dislocatis a loco ppio: ⁊ appellat ꝓiunctio disiunctoꝝ.

At aũt qñ vnusq; voluerit: valeat facilẽ inuenire dictũ ẽm i tũ: ⁊ ꝓiculus libꝝ istũ ordinate p capl̃a ꝓtes singulas distinguẽdo: ita tñ. q in ꝑma ꝑte but⁹ libꝝ nõ in spãli: ꝛz ib q̃dã itẽdimus. gñalitate tractare. ¶Diuidit aũt liber iste in ꝛtuoꝛ ꝓtes. ¶In ꝑma ꝑte agit vir de vulneribꝰ. vlceribꝰ. de fluxu sanguis. ⁊ medicinis ipsoꝝ. de ludicijs motiꝰ. de vulneribꝰ neruoꝝ: cura aꝑatis cali: atq; palmi. ¶In 2a ꝑte tractat de cisdẽ fm q̃ cuilibet mẽbio cyrurgia ꝛerercẽ nec̃e est a capite vsq; a pedes. ¶In 3a ꝑte dicit de fistulis. cãcro. formica. cãcrenis. scabie. ⁊ ceteris aꝑatib⁹. ⁊ infectionib⁹. que in manifesto coꝛpis bũani ꝛtingit. ¶In 4a ꝑte ⁊ vltia finiemus libꝝ scribẽdo aliq̃ a nob ꝓbata de dolore capitis ⁊ emigranea ⁊ tractãdo de egritudib⁹ octoꝝ. auriũ. narium. oriꝫ. ⁊ dẽtiũ. arterice. ⁊ podagre. ⁊ sic vita comite finiem⁹ ꝓcedẽte, dño libꝝ istũ. Et hec sunt capl̃a primi libri.

Capitulum primũ De causis vulnerum ⁊ diuisione ipsorum.

De dispõne vulnerum fm diuersitatem mẽbroꝝ. 1m
De vsi curatione vulnerum que fiunt in carne. 3m
De figuris vulnerũ ⁊ cura ipsoꝝ: ⁊ modo ligandi. 4m
De causis vulnerũ que tarde sanantur ⁊ eoꝝ cura. 5m
De vulneribus cronicis. 6m
De oibus diuersitatibus vlcerũ: ⁊ de cura ipsoꝝ. 7m
De medicinis sanie generãtibus circa membrum. 8m
De diffinitiõe ⁊ nã medicaminũ. qb⁹ vtimur in vulneribus ⁊ vlceribus. et de bis que attendenda sunt circa cõpsonem nãlem membꝛi vulnerati. ⁊ de modo administrationis dictorum medicaminum. 9m
De medicinis incarnatiuis. 10m
De medicinis facientibus nasci carnem. 11m
De medicinis ꝓsolidatiuis ⁊ cicatriçatiuis. 12m
De fluxu sanguinis ab exterioribus corporis. 13m
De fluxu sanguinis a membris interioribus. 14m
De solutione continuitatis scissura et punctura earum et apostemate ipsorum. 15m
De incisione neruorum per latitudinem. 16m
De contusionibus ⁊ doloribus lacertorum. 17m
De vulnere ligamentoꝝ ⁊ chondarum. 18m
De vulnere ex contusione accidente. 19m
De aꝑate calo supueniẽte vlneri ⁊ pbitẽ ⁊ cura ipsi. 20m
De iudicijs motiꝰ et periculi in quibus communicant vulnera quorundam membroꝝ. 21m
De excisione sagitte ⁊ modo ⁊ forma ipsarum. 22m
De excisione spinarũ aculariũ. ⁊ filium qñ corpus ingre. De spasmo et cura eius. 24m (dunt. 23m
De dieta ⁊ regimine infirmoꝝ. 25m
De quibusdam potionibus et mixtionibus app: optimis vulnerum et vlceribus. 26m

THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

ALFRED BROWN, M.D, F.A.C.S, Omaha, Nebraska

THE SURGERY OF THEODORIC

"AFTER him (Brunus) immediately came Theodoric, who, stealing all that Brunus had said, and adding certain fables of Hugo de Lucca, his master, published a book." In this sentence Guy de Chauliac dismisses Theodoric, but correct as he might be in the surgical ideas of his time, Guy shows himself somewhat wrong in his estimate of this author and may possibly have reversed the positions of Brunus and Theodoric for the latter was the son of Hugo de Lucca of whom Guy speaks and acted more or less as his amanuensis, writing after his death, and Hugo was a much older man than Brunus. It is necessary, therefore, in order to get an insight into Theodoric's surgery to study the life and work of his father.

Hugo Borgognoni or Hugo de Lucca lived during the twelfth and thirteenth centuries and died in the sixth decade of the thirteenth at an age of nearly one hundred years. He did not gain much prominence until the early part of the thirteenth century when he was called to Bologna in 1214. He then became an army surgeon for a time, served in the crusade, and was with the army in the siege of Damietta. In 1221 he returned to Bologna and helped to found the School which later attained such great fame. Hugo had five sons and of these three became physicians. They were taught by their father who was apparently much imbued with the ancient Greek ideas for he instructed them all according to the ancient Æsculapian family idea and handed his knowledge on to them under the seal of secrecy. Consequently, Hugo himself wrote no book and we must turn to his famous son, Theodoric, to learn his father's ideas. These he incorporates into his book, and, though in its general arrangement his book resembles that of Brunus, in some places the two being almost identical; there is much in Theodoric's work that is not even mentioned in Brunus's. To take one part as an example, Theodoric says: "It has been told, however, how that wonderful man master Hugo invented the method of using wine and stupes and ligatures alone to treat almost all wounds and healed, consolidated, and induced the most beautiful scars without the use of any ointments, rapidly and with skill, in the best way possible." There is no reason to believe that Theodoric is not telling the truth in this statement and if he is, Hugo is the founder of the school of wet dressings instead of Brunus to whom Guy de Chauliac gives the credit. When Brunus wrote his surgery in 1252 he was 38 and Hugo was almost a hundred years of age and it is only reasonable to conclude that he had practiced his method and taught it to his son long before this.

Theodoric, Hugo's son, was born in Lucca and was six years of age when his father moved to Bologna. In addition to studying medicine he entered the order of the Dominican monks and spent the greater part of his life in close connection with the potentates of the church. He became the father confessor of Pope Innocent IV after he had been chaplain to the Catalonian, Andreas de Ablatus. Because of this connection he became first, the Bishop of Binoni and later Bishop of Cervia. In spite of these appointments he lived almost constantly in Bologna and had a large, lucrative practice. He died in 1298 at the age of 93 years.

Theodoric's surgery appeared in print first as part of the *Collectio Chirurgia Venecta* which was published in 1498. Later it was printed as part of the collection headed by the great surgery of Guy de Chauliac and the page reproduced here is from the edition of that collection which was printed by Gregorius de Gregorio at Venice in 1513.

The work is divided into four chapters or books. The first deals with wounds, ulcers, infections, etc; the second carries the subject further and describes these conditions as they occur in various parts of the body; the third is devoted to fistulæ, cancer, etc.; and the fourth takes up the head, diseases of the eyes, paralysis, epilepsy, etc.

The introduction, which deals with the definition of surgery and its requirements, is almost identical in its ideas with the corresponding portion of Brunus's introduction. The language of Brunus is, however, a little more involved than that of Theodoric. Probably the most important advance that Theodoric made was in the treatment of fractures and dislocations. He was the first surgeon to wage war against, and discard the use of, the horrible machines which since the time of the early Greeks, and particularly since the time of Oribasius the Byzantine, had been used in the reduction of these deformities. Instead of these he advocates the use of broad bandages. He thus marks himself as one of the first surgeons to progress beyond medieval barbarism and employ humanitarianism in the treatment of his patients suffering from traumatic conditions.

REVIEWS OF NEW BOOKS

THE book by Flaskamp[1] contains a collection of all the known facts concerning possible damage resulting from the roentgen rays and other radioactive substances and will undoubtedly find its way very soon into the library of every member of the legal and medical profession who has an active interest in the medicolegal aspects of X-ray and radium damages. The book is a valuable contribution to science in that the literature of the world has been carefully studied, and all the facts relating to damages from roentgen rays and other radio-active substances have been gathered together in one work. The volume, therefore, constitutes a document of unusual worth. JAMES T. CASE.

AFTER a brief historical introduction the author of *Die Schwangerschaftsdiagnose aus dem Harne*[2] defines clearly and concisely the principles underlying the method developed by Zondek and himself for the diagnosis of pregnancy from the urine. The chapters which follow explain in detail the technique and clinical results of the method, pointing out sources of error and presenting corroborative evidence obtained from urine findings in pregnant animals. The final chapter is devoted to the application of their discovery of the anterior-pituitary-ovarian relationship to other facts of human physiology and pathology. In conclusion the author points out the far-reaching possibilities of this method of investigation in solving questions of endocrine therapy.

A perusal of this monograph will leave little doubt in the mind of the reader that the procedure represents one of the outstanding contributions to medical science in recent times. The importance of this test extends beyond its clinical application in the early diagnosis of pregnancy since it throws light upon many hitherto unsolved problems of physiology and pathology of the endocrine system in general and of the sex glands in particular. HAROLD C. MACK.

IN the compiling of the 1929 volume of *Collected Papers of the Mayo Clinic and the Mayo Foundation*,[3] a selection was made from 471 papers published by the Staff. Ninety are reprinted in full—23 are abridged, 68 are abstracted, and references are given to 290. As in the past, preference was given to subjects of interest to the general practitioner, the diagnostician, and the general surgeon, at least so reads the foreword. However, it would perhaps be more accurate to say that the subject matter embraces every recent advance in surgery. There is also much of interest for the internist and the general practitioner.

The subject matter is divided into systems. It would be vastly impossible to review all of the important matter presented here. The alimentary tract still claims the lion's share and deservedly so. For it was in the Mayo Clinic that so many of the important contributions to the surgery of the stomach, the duodenum, and the biliary passages were made. In this section Balfour contributes papers on dyspepsia, on the problem of the recurrent peptic ulcer, and on the management of lesions of the posterior wall of the duodenum. Judd reports a case of total gastrectomy and discusses in another paper surgery of the biliary tract. Rankin contributes several papers to the surgery of the colon and rectum.

In the section on ductless glands, the reader will find a number of interesting contributions, such as "The Oxygen Treatment of Complications Incident to Goiter," "Surgical Treatment of Hyper-Insulinism," "Management of Severe Goiter Cases," "Hyper-Parathyroidism," etc.

In the section on blood and circulatory organs, a paper of unusual interest for many reasons is that by W. J. Mayo. Its title is, "Surgical Aspects of Diseases of the Lymphoid Organs, with Special Reference to the Spleen; with a Statistical Report of the Results Following the Removal of the Diseased Spleen in 530 Cases." The clinical significance of such vast material analyzed by a master mind can hardly be overestimated.

To read this volume is to watch American surgery on its forward march. GEORGE HALPERIN.

THE authors of *Physiologie Pathologique Chirurgicale*[4] present certain pathological problems in surgical practice. The work is divided into chapters dealing with inflammation, trauma, repair of wounds transplants, diseases of bones and joints, blood vessels, and nerves. The authors present their own views based on their own clinical experience and experimental work. For this reason, references to the literature are largely omitted. Their attitude toward illustrations is rather interesting. They feel that illustrations, particularly the use of many illustrations, constitute one of the worst abuses of modern surgical literature. They believe that surgeons have become sufficiently intellectual not to require an appeal to the visual. Their preference is to appeal directly to the intellect of the reader.

The text discloses an intimate knowledge of the underlying fundamental sciences of physiology, his-

[1] SONDERBAENDE ZUR STRAHLENTHERAPIE. Vol. XII—Ueber Roentgenschaeden und Schaeden Durch Radioaktive Substanzen, Ihre Symptome, Ursachen, Vermeidung und Behandlung. By Priv.-Doz. Dr. Wilhelm Flaskamp. With a Foreword by Prof. Dr. med. et phil. Herman Wintz. Berlin and Vienna: Urban & Schwarzenberg, 1930.

[2] DIE SCHWANGERSCHAFTSDIAGNOSE AUS DEM HARNE (ASCHHEIM-ZONDEK REAKTION): PRAKTISCHE UND WISSENSCHAFTLICHE ERGEBNISSE AUS TAUSEND HORMONALEN HARNANALYSEN. By Dr. S. Aschheim. Berlin: S. Karger, 1930.

[3] COLLECTED PAPERS OF THE MAYO CLINIC AND THE MAYO FOUNDATION. Edited by Mrs. Mellish, Richard M. Hewitt, B.A., M.A., M.D., and Mildred A. Felker, B.S. Vol. xxi, 1929. Philadelphia and London: W. B. Saunders Co., 1930.

[4] PHYSIOLOGIE PATHOLOGIQUE CHIRURGICALE; INFLAMMATIONS, EFFECT DES TRAUMATISMES RÉPARATION DES PLAIES, GREFFES, MALADIES DES OS, DES ARTICULATIONS, DES VAISSEAUX ET DES NERFS. By R. Leriche and A. Policard. Paris: Masson et Cie, 1930.

tology, and pathology coupled with an analytical and philosophical attitude which make the reading of these short essays highly instructive and suggestive. This is surgical literature at its best. It clearly indicates the trend of modern surgical thought in the direction of physiological research.

GEORGE HALPERIN.

AN unusual volume[1] has been written by Koblanck. The book embodies the results of many years of clinical experience and observation as well as the findings obtained by animal experimentation. It is the author's notion that the nose is intimately connected by way of its innervation with most of the important organs of the body. It is also his idea that because of this intimate connection, various diseases may be influenced by treatment of the nose. The pioneer work of Fliess in this connection is recognized and credit given to him and others. The number of diseases the author undertakes to influence partly by treatment directed toward the nose is legion, varying as it does from such disturbances of the female genital apparatus as amenorrhœa, dysmenorrhœa, sterility, etc., to other such disturbances as asthma, hay fever, neuroses of different types, epilepsy, migraine, and psychic ailments. Much of what the author takes for granted would not be acceptable in other quarters. A great deal of his conclusions are based upon shrewd clinical observation and in the future may be or may not be corroborated by evidence of a much more scientific nature. Such as it is, the work has merit, representing a large clinical experience in a field possessing unusual interest for all medical men.

The book is well documented with copious references to the literature and the author goes to great pains in giving detailed case reports of numerous patients in order to back up his conclusions.

S. J. P.

THIS exhaustive treatise[2] deals entirely with the subject of hydronephrosis and its associated pathology. The latter naturally includes nearly all of the so called "surgical" diseases of the kidney. Beginning with the earliest recognition of hydronephrosis in 1672 the author enumerates in chronological order each valuable addition to the knowledge of the subject. This includes a clear and detailed reference to anatomical, physiological, pathological, and clinical contributions. A more complete résumé cannot be found elsewhere. All experimental data on the subject of ureteral physiology and anatomy which have been published at home and abroad are cited.

In the clinical discussion the author has as a basis for his various conclusions a personal experience embracing several hundred instances of all types of ureteral and renal pelvis dilation. The atlas, which contains 402 anatomical figures and reproduced pyelograms, is the most instructive of its kind recently published. The work is characterized by an unusual clarity and conciseness and, while considering hydronephrosis primarily, it really embraces nearly all the pathology of the kidney except nephritis. This book can be most enthusiastically recommended to all those who are interested in diseases which affect the upper urinary tract.

VINCENT J. O'CONOR.

THE latest volume of the *Handbuch der Urologie*[3] is an impressive symbol of German achievement in this specialty. On close inspection one is conscious of slight disappointment, especially in two particulars: the illustrations are neither as numerous nor as good as one expects from the German presses, and the references to the literature show few quotations later than 1923, and almost none later than 1925. Five years is a long time in modern medicine, and manuscripts that old already begin to show signs of senility.

The difficulty of classification is illustrated by the first chapter on the ureter. Previous chapters on general subjects have shorn this chapter down to ureteritis, stricture, ureterocele, and tumors. An excellent index helps to neutralize this difficulty, but it is to be hoped that the last volume to be issued will contain a general index referring to all the volumes.

Paschkis, in the chapter on the bladder, groups Fenwick ulcer, Hunner ulcer, and submucous cystitis under the general heading of ulcus simplex. It seems to the reviewer that this contributes to confusion rather than clarity. A section on the involvement of the bladder in hernias is interesting.

Joseph describes his method of chemical coagulation of bladder tumors with trichloracetic acid for which he claims many advantages. In regard to radium implantation, he says that he feels that all of our present methods are so unsatisfactory for infiltrating carcinoma that the only real hope lies in the development of total cystectomy.

The scrotum, testes, epididymis, urethra, and penis are covered in rather orthodox fashion. One notes that it is advised never to use a suspensory in varicocele, and also that injections of iodine are admitted for obliterating congenital or communicating hernia.

Schwartzwald has produced a really encyclopædic treatise on the seminal vesicles, a work which has been much needed. Blum and Rubritius contribute the chapter on the prostate. Latzo contributes a long chapter on "Gynecological Urology," which is evidently the work of a wise and experienced clinician. While there is little pathology, it bridges very usefully the gap which exists between urology and gynecology, and it is well worth careful reading.

D. M. D.

[1] DIE NASE ALS REFLEXORGAN; DES AUTONOMEN NERVENSYSTEMS. By Dr. Alfred Koblanck. With foreword by Prof. Dr. Friedrich Matthaei. Berlin and Vienna: Urban & Schwarzenberg, 1930.

[2] LES HYDRONÉPHROSES; ANATOMIE ET PATHOGÉNIE. By Edmond Papin. Paris: G. Doin et Cie, 1930.

[3] HANDBUCH DER UROLOGIE. Edited by A. v. Lichtenberg, F. Voelcker, and H. Wildbolz. Vol. v. Spezielle Urologie, iii. Berlin: Julius Springer, 1928.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

CARE OF THE INFANT AND CHILD; A BOOK FOR MOTHERS AND NURSES. By Harry R. Litchfield, M.D., and Leon H. Dembo, M.D. Baltimore: Waverly Press, Inc., 1930.

THE PRINCIPLES AND PRACTICE OF MEDICINE; DESIGNED FOR THE USE OF PRACTITIONERS AND STUDENTS OF MEDICINE. Originally Written by the late Sir William Osler, Bt., M.D., F.R.S. 11th ed. rev. by T. McCrae, M.D. New York and London: D. Appleton and Company, 1930.

UNIVERSIDAD DE CHILE BOLETIN ANUAL DE LA CLINICA GINECOLOGICA. Vol. i (1929). Santiago de Chile: Imp. y Lito. Leblanc, 1930.

TEXT-BOOK FOR NURSES; ANATOMY, PHYSIOLOGY, SURGERY AND MEDICINE. By E. W. Hey Groves, M.D., B.Sc., M.S., F.R.C.S., and the late J. M. Fortescue-Brickdale, M.A., M.D. (Oxon.), M.R.C.P. (Lond.). The Medical Section Revised by J. A. Nixon, C.M.G., M.D. (Cantab.), F.R.C.P. (Lond.) 4th ed. New York and London: Oxford University Press, 1930.

BIOLOGÍA Y PATOLOGÍA DE LA MUJER; TRATADO DE OBSTETRICIA Y GINECOLOGÍA, publicado bajo la dirección de los Josef Halban y Ludwig Seitz. Traducido directamente del original alemán por Joaquín Núnez Grimaldos, con la colaboración técnica del Dr. D. Arcadio Sánchez López. Vols. v and vi. Madrid: Editorial Plus Ultra, 1930.

CLINICAL ALLERGY; ASTHMA AND HAY FEVER MECHANISM AND TREATMENT. By Francis M. Rackemann, M.D. New York: The Macmillan Company, 1931.

ABDOMINO-PELVIC DIAGNOSIS IN WOMEN. By Arthur John Walscheid, M.D. St. Louis: The C. V. Mosby Company, 1931.

PRATIQUE UROLOGIQUE CHIRURGICALE. By Ed. Michon and L. Michon. Paris: G. Doin et Cie, 1931.

LES TUMEURS CÉRÉBRALES; LEUR MANIFESTATIONS, LEUR TRAITEMENT CHIRURGICAL. By Th. de Martel and J. Guillaume. Paris: G. Doin et Cie, 1931.

DEFORMITAETEN UND KOSMETISCHE OPERATIONEN DER WEIBLICHEN BRUST. By Dr. Hermann Biesenberger. Vienna: Wilhelm Maudrich, 1931.

THE PATHOLOGY OF INTERNAL DISEASES. By William Boyd, M.D., M.R.C.P., Ed., Dipl. Psych., F.R.C.S. Philadelphia: Lea & Febiger, 1931.

TECHNIQUE AND RESULTS OF GRAFTING SKIN. By H. Kenrick Christie, M.S. (N.Z.), F.R.C.S. (Eng.). New York: Paul B. Hoeber, Inc., 1931.

PHYSICS OF RADIOLOGY, etc. By J. L. Weatherwax, M.A. With a Foreword by Henry K. Pancoast, M.D. New York: Paul B. Hoeber, Inc., 1931.

LANDMARKS AND SURFACE MARKINGS OF THE HUMAN BODY. By L. Bathe Rawling, M.B., B.C. (Cant.), F.R.C.S. 6th ed. New York: Paul B. Hoeber, Inc., 1927.

MODERN SURGERY; GENERAL AND OPERATIVE. By John Chalmers DaCosta, M.D., LL.D., F.A.C.S. Assisted by Benjamin Lipshutz, M.D., F.A.C.S. 10th rev. ed. Philadelphia and London: W. B. Saunders Company, 1931.

TRAUMATOTHERAPY; THE TREATMENT OF THE INJURED. By John J. Moorhead, B.Sc., M.D., F.A.C.S., (D.S.M.). Philadelphia and London: W. B. Saunders Company, 1931.

PRACTICAL RADIATION THERAPY. By Ira I. Kaplan, B.S., M.D. With a special chapter on Applied X-Ray Physics by Carl E. Bruestrup, B.Sc., P.E. Philadelphia and London: W. B. Saunders Company, 1931.

ATLAS DE ANATOMÍA DEL ORGANO DEL OÍDO; Y DE LAS REGIONES CON ÉL VINCULADAS. By Dr. Pedro Belou. Buenos Aires, 1930.

A MANUAL OF SURGERY FOR STUDENTS AND GRADUATES. By Francis T. Stewart, M.D., and Walter Estell Lee, M.D. 6th rev. ed. Philadelphia: P. Blakiston's Son & Co., Inc., 1931.

BIOGRAPHISCHES LEXIKON; DER HERVORRAGENDEN AERZTE ALLER ZEITEN UND VOELKER. By various collaborators, edited by Dr. E. Gurlt, Dr. A. Wernich, and Dr. August Hirsch. 2d ed. rev. and enlarged by Prof. F. Huebotter and Prof. H. Vierordt. Vols. i, ii, and iii. Berlin and Vienna: Urban & Schwarzenberg, 1929.

LEZIONI DI CLINICA CHIRURGICA. By Davide Giordano. S. Daniele, Friuli, Italy: Arti. G. Tabacco, 1930.

SURGICAL EMERGENCIES IN PRACTICE. By W. H. C. Romanis, M.A., M.B., M.Ch. (Cantab.) F.R.C.S. (Eng.), F.R.S. (Edin.), and Philip H. Mitchiner, M.D., M.S. (Lond.), F.R.C.S. (Eng.). New York: William Wood & Company, 1931.

IL COMPORTAMENTO ISTOLOGICO DEI TRAPIANTI OSSEI AUTOPLASTICI VIVENTI IN SEDE OSSEA CHIUSA, CON PARTICOLARE RIGUARDO AL LORO IMPIEGO NELL'OSTEOSINTESI PER INCAVIGLIAMENTO. By Dottor Mario Borghi. Milan: Società Anonima Poligrafica, 1930.

ANTE-NATAL CARE. By W. F. T. Haultain, O.B.E., M.C., B.A., M.B. (Camb.), F.R.C.S.E., M.R.C.P.E., M.C.O.G., and E. Chalmers Fahmy, M.B. (Edin.), F.R.C.S.E., M.R.C.P.E., M.C.O.G. With foreword by Professor R.W. Johnstone, C.B.E., M.A., M.D., F.R.C.S.E., F.C.O.G., M.R.C.P.E. 2d ed. New York: William Wood & Co., 1931; Edinburgh: E. & S. Livingstone, 1931.

PYE'S SURGICAL HANDICRAFT: A MANUAL OF SURGICAL MANIPULATIONS, MINOR SURGERY, AND OTHER MATTERS CONNECTED WITH THE WORK OF HOUSE SURGEONS AND SURGICAL DRESSERS. Edited by H. W. Carson, F.R.C.S. (Eng.). 10th ed. rev. New York: William Wood & Company, 1931.

CANCER; ITS ORIGIN, ITS DEVELOPMENT, AND ITS SELF-PERPETUATION, etc. By Willy Meyer, M.D. New York: Paul B. Hoeber, Inc., 1931.

NINTH SCIENTIFIC REPORT ON THE INVESTIGATIONS OF THE IMPERIAL CANCER RESEARCH FUND. Under the direction of the Royal College of Physicians of London and the Royal College of Surgeons of England. London: Taylor and Francis, 1930.

DAS GYNAEKOLOGISCHE SEMINAR; PRAKTISCHE GYNAEKOLOGIE MIT BESONDER BERUECKSICHTIGUNG DER SOZIALEN FRAUENKUNDE. By Dr. Wilhelm Liepmann. Berlin and Vienna: Urban & Schwarzenberg, 1931.

OPERATIVE OBSTETRICS ON THE MANIKIN; FOR STUDENTS AND PRACTITIONERS. By Charles B. Reed, M.D., F.A.C.S. Philadelphia: P. Blakiston's Son & Co., Inc., 1931.

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